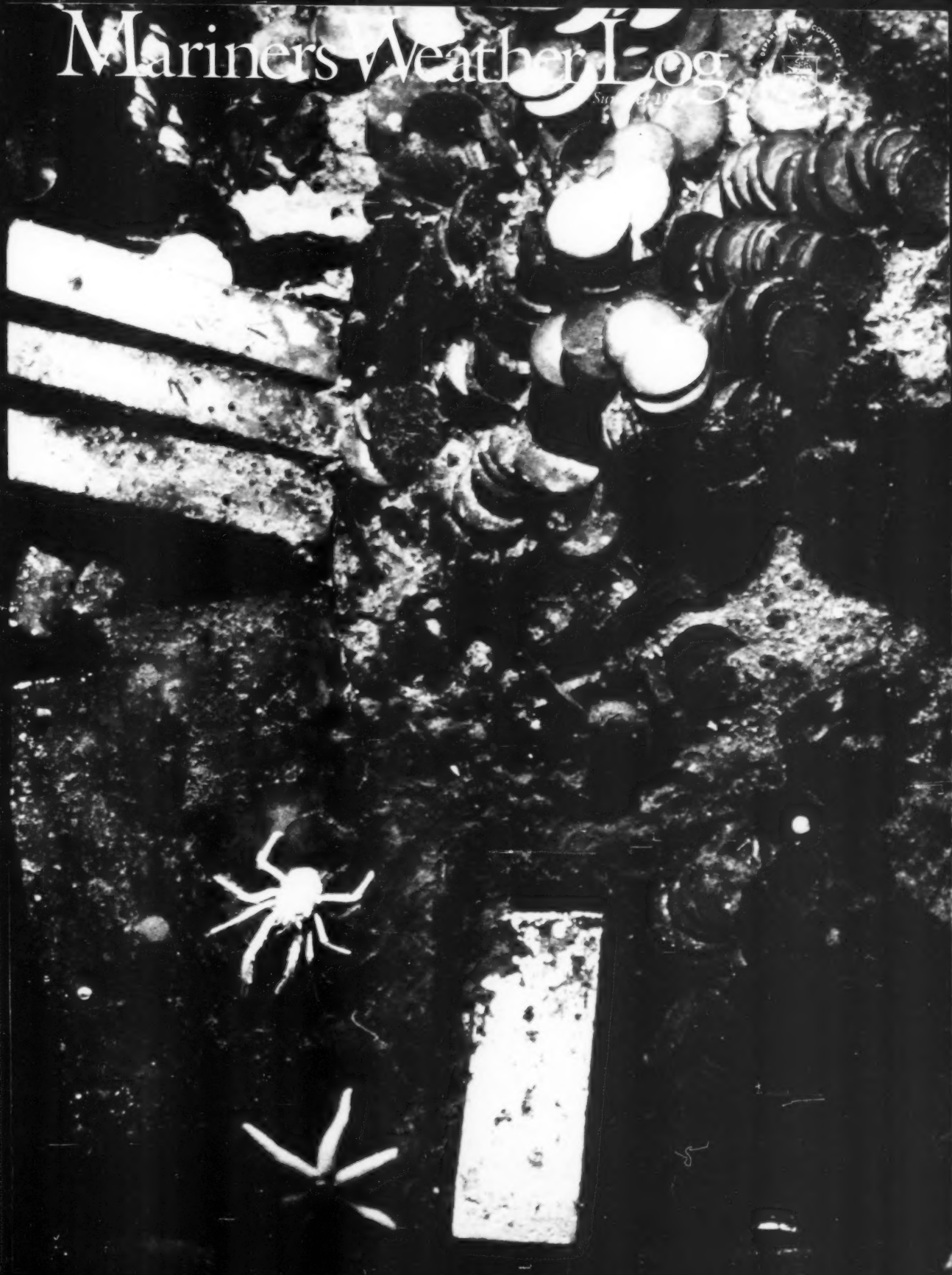
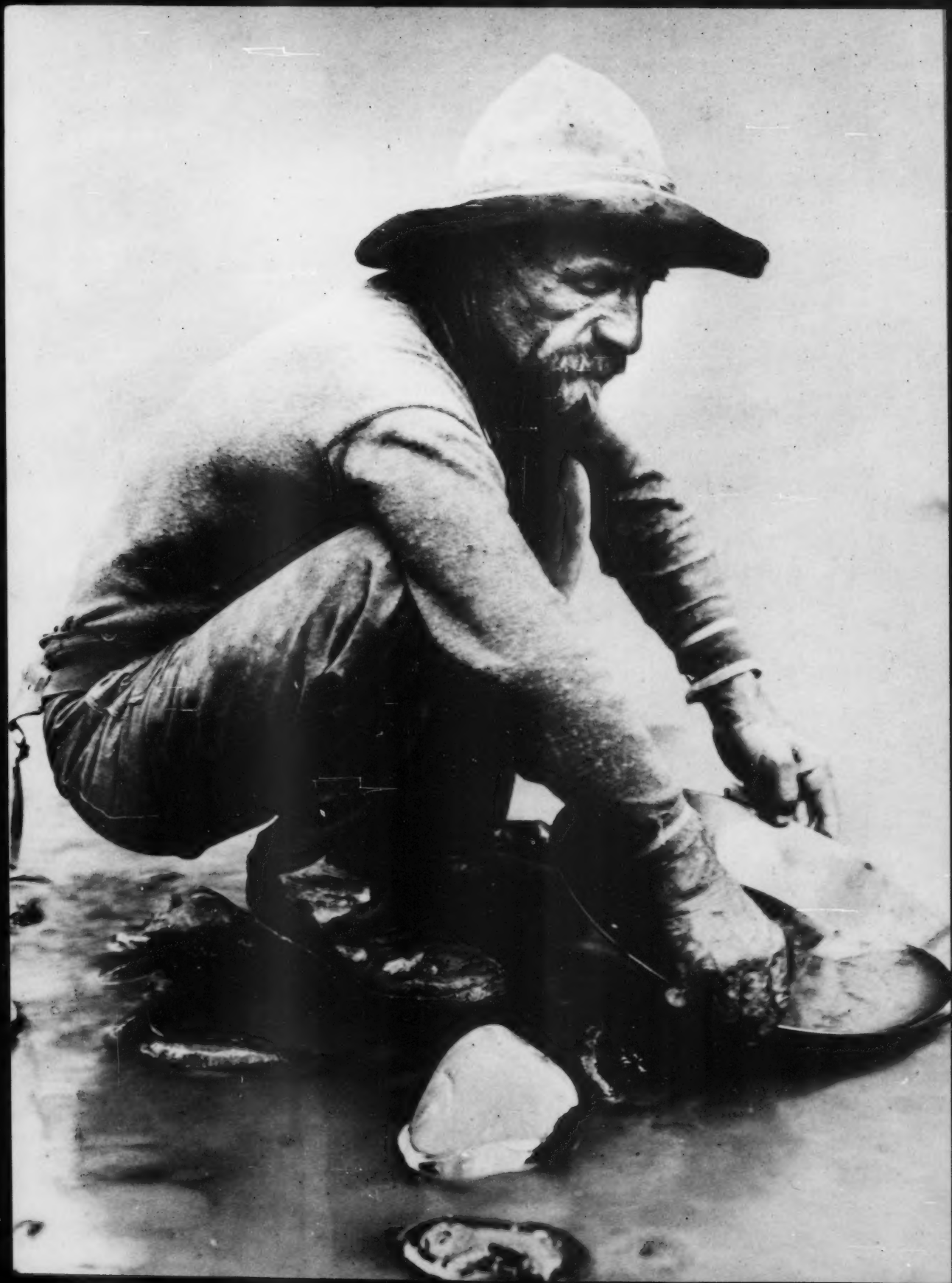


Mariners Weather Log

September 1999





Mariners Weather Log



Central America Special

4 Hurricane Gold*

Part 1—The Loss

Charles E. Herdendorf and Judy Conrad
A hurricane sank the S.S. Central America in 1857.

14 Hurricane Gold*

Part 2—The Find

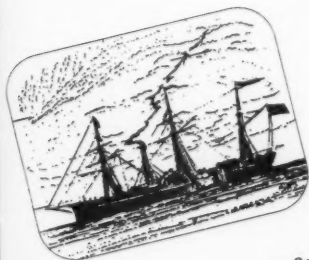
Charles E. Herdendorf and Judy Conrad
Hurricanes hampered the recovery of the S.S. Central America's treasure some 130 years after the sinking.

16 SEAS III and Beyond

Patrick McHugh

SEAS units bring the marine weather observer into the personal computer age.

** related to the S.S. Central America expedition*



The **California** (above) ushers in the Gold Rush era for mariners. See page 34.

At right, the rescue of the women and children were of prime concern to the Master of the **S.S. Central America**. Story on page 4.



Cover: Gold and timbers from the S.S. Central America attract sea life to a Hollywood setting nearly 8,000 feet below the sea surface. Photo © Columbus—America Discovery Group, Inc.

Inside Cover: A prospector pans for gold. Although there was plenty of gold, only a few had the luck, stamina and wits to cash in. The rich areas had been grabbed early on by California ranchers, who became the founding families of San Francisco. Many men were taken and ended up exchanging their bag of gold for a passage home. Photo courtesy of the Western History Collection of the Denver Public Library.

Back Cover: A display of a portion of the S.S. Central America's treasure. Photo © Columbus—America Discovery Group, Inc.

July, August and September 1991
Vol. 35, No. 3



Boston Lighthouse was first lit on September 14, 1716. Elinor DeWire tells us who—Page 28.

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Mariners Weather Log



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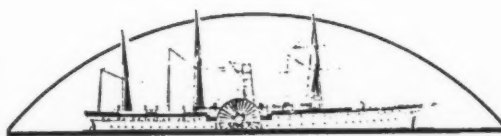
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Columbus-America Discovery Group



The S.S. Central America Project

Thanks to the generosity of the Columbus-America Discovery Group we are able to share in an adventure that involves weather, gold and history. The scientific interest of the group is apparent in the articles and, like most of our Voluntary Observing Ships, they are willing to take the time to assist the National Weather Service and the National Oceanographic Data Center in data collection.

The group was formed in 1985 to conduct multi-disciplinary research and develop sophisticated deep-ocean technology, and to locate, explore and recover the remains of the *S.S. Central America*. The management team consists of Thomas G. Thompson, the group's founder and principal director, and project directors Robert Evans and Barry Schatz.

Tom Thompson is an ocean engineer with more than 10 years' experience in ocean recovery projects. He was a research scientist with Battelle Memorial Institute from 1980 to 1987, where he served as principal investigator on a concept and feasibility study for mining polymetallic sulfides in the deep ocean. Prior to that, he served as chief engineer aboard research vessels operating in the Caribbean and Pacific Oceans. Bob Evans joined Tom in researching the *S.S. Central America* and other historic shipwrecks in 1982. Prior to that he worked as a geological consultant and field scientist. Bob has also consulted in the field of scientific history, with an emphasis on 19th century scientific data interpretation.

Barry Schatz joined the Columbus-America Discovery Group in 1985. His background is in publishing, journalism and radio. Barry began his career as a newspaper reporter in Michigan and later served 4 years as Keys Correspondent for *The Miami Herald*. In Key West, he also produced jazz and popular Cuban (Spanish language) radio programs. Most recently, he served as editor at the University Presses of Florida.

George Payment Canadian Marine Meteorological Officer Retires



In the spring of 1991, George Payment a long time colleague and trusted international partner in the field of Marine Weather Observations announced that he would be retiring from the Atmospheric Environment Service (AES), a segment of Environment Canada within the Canadian Public Service.

George joined the Service in 1961 to become a Meteorological Technician. In 1967, he accepted a position as an Upper Air Technician at Ocean Station Papa, located in the northeastern North Pacific. While stationed there, George developed a special interest in the marine aspects of weather observing and within several years, he transferred to the Headquarters for the Atmospheric Environment Service, located in Downsview, Ontario, Canada, where he acted as the Marine

Meteorological Officer. It was during this time that George became invaluable to the Canadian Regional Port Meteorological Officers (PMO's) and to other marine weather personnel throughout the world.

Under the Canadian Voluntary Observing Ship (VOS) Program, which he promoted, George acted as an advocate between the AES (PMO's) and the mariners who took synoptic weather observations at sea. He coordinated various nationally based marine workshops and wrote summaries based on the acquisition of marine data. In conjunction with Regional PMO's, George recommended modifications to improve the effectiveness of weather instruments used on board ships and contributed to the Marine Buoy Program through his involvement in the transmission of weather messages via the Geostationary satellites (GOES).

On June 28, 1991, George officially bade his peers a hearty "*Bon Voyage*" and traded his mariners logbooks and code cards for a 'hoc, trawl and passport' in order to pursue his long standing preoccupations of gardening and travelling. George is an avid gardener, who we have been told, "produces the finest home grown vegetables in North America." It is during the long winter months (when it is difficult to go outdoors, let alone garden) that he intends to travel.

During the course of his long career, George devoted many hours to various aspects of Marine Weather Services. He became known as the "Canadian Focal Point" within the service in marine matters. Internationally he was recognized as a man with integrity and "one who could be counted on to get the job done." Indeed, it is with regret that we bid George a fond farewell, and wish him "all the best" in his future endeavors.

—Brenda L. Smith
Atmospheric Environment Services



The S.S. Central America Expedition

HURRICANE GOLD

PART I—THE LOSS

Charles E. Herdendorf and Judy Conrad
Columbus-America Discovery Group



Charles E. Herdendorf is science coordinator for the S.S. Central America Expedition. Dr. Herdendorf is Professor Emeritus of oceanography at The Ohio State University, where he also served as Director of the Ohio Sea Grant College Program. Judy Conrad is a historian for the Columbus-America Discovery Group. Ms. Conrad is editor of the book *Story of an American Tragedy: Survivors' Accounts of the Sinking of the Steamship Central America*. The authors gratefully acknowledge the assistance of Robert Evans and Barry Schatz, directors of the Columbus-America Discovery Group. The material that follows is copyrighted by the Columbus-America Discovery Group, Inc., except where noted.

The S.S. *Central America* foundered in an 1857 hurricane off Savannah, Georgia, with the loss of more than 400

lives and tons of California gold. It's been called America's *Titanic*—the greatest civil maritime disaster in U.S. history. For some 130 years this vessel rested undetected, nearly 8,000 feet below the ocean's surface. It was discovered by a team of engineers and scientists from the Columbus-America Discovery Group aboard the *R/V Arctic Discoverer*—a vessel in NOAA's Voluntary Observing Ship (VOS) program.

For the passengers on board the *Central America*, the story began on the morning of August 20, 1857, when they boarded the Pacific Mail Steamship *Sonora* at Vallejo Street Wharf in San Francisco. Travelers aboard the *Sonora* represented a virtual cross-section of nineteenth-century America—judges and miners, merchants and gamblers, entrepreneurs and wage earners. Thirty-one of the four hundred-plus passengers were women, and twenty-nine were children. For many, this was their first ocean voyage; others were businessmen who made the trip regularly.

The *Sonora* left her berth at 10 minutes past 9 o'clock and proceeded to sea, carrying over \$1.5 million in California gold.

Among the first cabin passengers were Ansel and Addie Easton. Addie would later recall that,

"The voyage to the isthmus was one long delight, with smooth waters, sunny skies and a joyous congenial company."

On Thursday, September 3, the *Sonora* reached Panama, and all on board transferred to the Panama Railroad for the 4-hour trip across the isthmus. Waiting for them at the dock in Aspinwall was the S. S. *Central America*, commanded by 44-year-old William Lewis Herndon, a U.S. Navy officer.

The *Central America* left Aspinwall, Panama at 4 p.m. on September 3d. Records show that the total number of people on board was 578—476 passengers and 102 crew members.

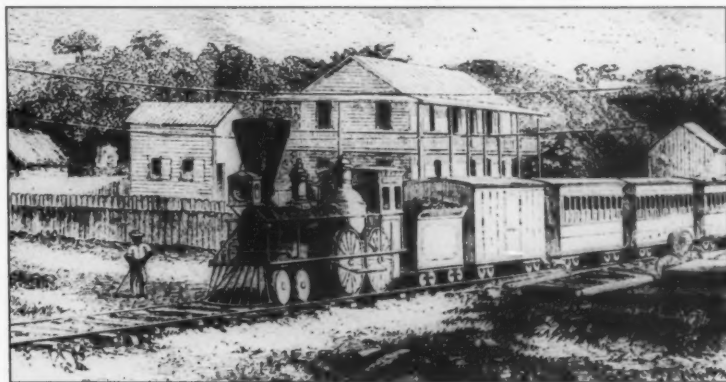
"We steamed out upon the Caribbean Sea watching the shores that we had left behind us fade away in the distance," recalled Oliver P. Manlove, a young steerage passenger, poet, and former gold miner. "The weather was fine and the sea was restful; not a ripple was to be seen...It was a great mirror of splendor."

Like the voyage from San Francisco to Panama, the trip to New York began with every indication that it would be a pleasant, peaceful voyage.

The ship arrived in Havana, Cuba, on September 7th. They left the following morning, as passenger J.A. Foster reported, "...with clear weather and every prospect for a pleasant passage."

The S.S. *Central America* is depicted in the lithograph (left), originally published by J. Childs of Philadelphia. Courtesy of the Peabody Museum.

The Panama Railroad connected the Atlantic and Pacific Coasts and was the easiest means of travel until the Canal was opened in 1914. Courtesy of University of California Press.



THE GOLD RUSH — SEEING THE ELEPHANT



Smithsonian Institution Photo No. 38416-C

San Francisco's Gold Rush Days

James Marshall, on a chilly January morning in 1848, was inspecting the progress on a sawmill he and his crew were building in Coloma Valley for a man named John Sutter, when a glint of metal in the water caught his eye. It was gold. Sutter and Marshall tried to keep the discovery secret. However, on March 14, 1848 a short article entitled "Gold Mine Found" appeared in a San Francisco newspaper. Few people noticed or cared. The *California Star* ran several articles about the gold, but it wasn't until May 28th, when Samuel Brannan rushed into San Francisco, with a quinine bottle full of gold, and trumpeted the news all over the City, that realization set in. Within days San Francisco was deserted by most of its male population. Stores were closed and newspapers suspended. The *California Gold Rush* was on—a migration that altered the course of world history. Gold fever spread throughout the U.S., and prospec-

tors arrived on horses, mules and ox-drawn wagons. Some walked 2,000 miles. Ships carrying emigrants and supplies were abandoned by their crews, who in some cases did not even wait long enough to stow sails and be paid off, so keen were they to join the wild race for gold. Soon it became a worldwide epidemic, or as *The Times* of London called it— "Gold Mania."

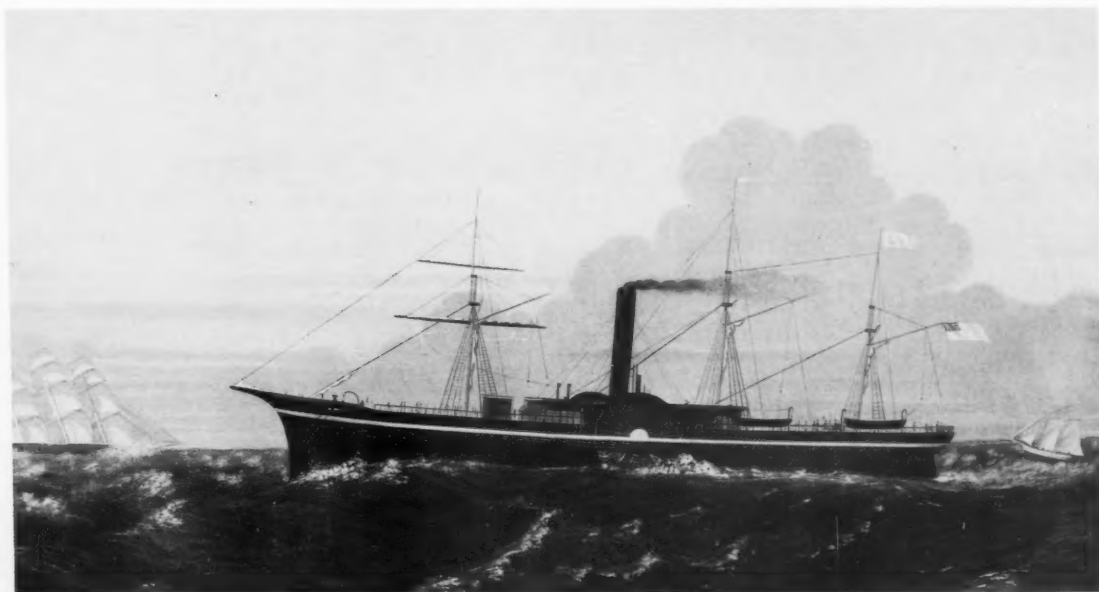
By late 1848 or early 1849, much of the world believed that California gold was theirs for the picking. Spurred by the potato famine they came from Ireland. Driven by political upheaval, the French, Germans and Italians arrived by the thousands. Promises of up to \$125 per month for simple labor drew adventurers from Japan, China, Australia and South America. In 1848 California's population was 18,000. By 1850, when the territory became the 31st state in the U.S., the population had risen to around 100,000 and one-quarter billion dollars in gold had been mined. Most emigrants

had never left home before, yet they traveled thousands of miles, risking their lives for California gold. Many perished along the way. Indians, cholera and typhus took their toll. Some died from foul water or rotten beef. Some were lost in the Sierras, in Death Valley and by the salt flats of Utah. Others shipwrecked on Cape Horn or succumbed to tropical diseases crossing the Isthmus of Panama. Yet they arrived by the thousands. For many it was the highlight of an otherwise dull life, for others it symbolized the end of poverty and oppression, the hope for a new life in a new world. A popular expression of the day was "seeing the elephant" or experiencing the incredible phenomenon of the Gold Rush.

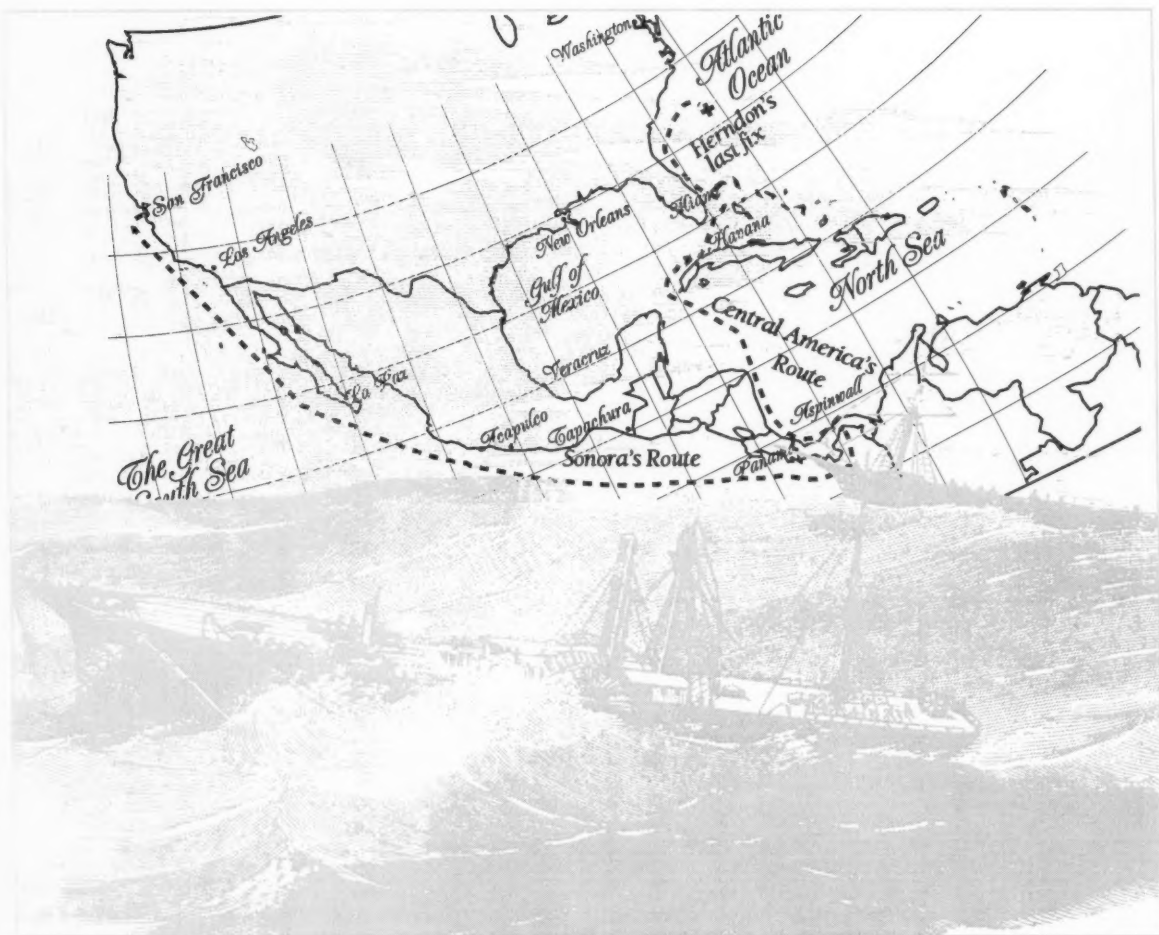
By sea, fortune-seekers came from across the Pacific, around Cape Horn or by way of Panama. On the Panama route early emigrants had to get to Chagres, often landing there by surf boat, head up the Chagres River in a native boat called a *bungo* and then walk or ride a mule across the low continental divide to the town of Panama. They were bitten by gnats, mosquitoes and ants, while cholera, yellow fever, dysentery and typhoid fever threatened an even worse fate. Still, they came. Between April 1847 and April 1848 just two ships visited the sleepy port of San Francisco. In 1849, some 775 vessels left Atlantic ports for San Francisco and 91,405 passengers landed at the port from all over the world. The California Clipper era, which lasted from about 1850 to 1860, reached a peak in 1853, when 48 clippers were added to the fleet. However the use of steam was becoming popular and practical.

The shortage of vessels to transport gold and passengers stimulated the New York shipbuilding industry of the 1850s. Here, William Webb designed and constructed coastal steamships and George Quintard of Morgan Iron Works built steam engines and paddle wheels to power the ships. One of their vessels, the *George Law*, soon to become the *Central America*, sailed into Gold Rush era history in 1857.

The *Central America* was a luxury coastal liner of her day. She was 278 feet long, constructed of pine and oak timbers with copper sheathing to protect the hull against shipworms and powered by two huge Morgan steam engines which drove mid-ship paddlewheels. Her oversized boilers and massive engineworks accounted for an estimated 750 tons of the ship's weight. The twin boilers burned about 60 tons of coal each day, thus the 20-day round-trip journey from New York to Panama required some 1200 tons of coal. She plied the Atlantic leg of what was known as the Panama Route. For two decades following the discovery of gold, the Panama Route was the preferred crossing between the Atlantic and Pacific coasts. Thousands of passengers as well as enormous amounts of mail and tons of gold treasure traveled over it every year. Twice a month side-wheel steamships would leave New York and San Francisco for the Isthmus of Panama. By the summer of 1857, the *Central America* had successfully completed 43 round trip passages between New York and Aspinwall, Panama. She sank on her 44th voyage, on September 12, 1857, 9 days after leaving Aspinwall.



Mariners' Museum



However, that prospect began to change on Wednesday, September 9. Passenger Virginia Birch was on deck with a group of other ladies when, as she later recounted: "A squall came up, and the wind blew like a hurricane, and we had to go downstairs." Another passenger, B. M. Lee, said: "Toward night the seamen began to call it a storm."

"On Thursday," said Thomas W. Badger, "It blew a perfect hurricane, and the sea ran mountains high." We can assume that Badger knew a hurricane when he saw one, because he was captain of his own bark, the *Jane A. Falkenberg*, of San Francisco.

All day and all night the storm raged. Passengers and crew awoke on Friday morning to find conditions no better. "It blew a perfect gale," said 17-year-old Henry T. O'Connor, a printer. "The sea ran mountains."

However horrifying the hurricane may have been, the passengers and crew of the *Central America* soon had even more to worry about. "At 9 a.m.," reported Chief Engineer George Ashby, "I discovered that the ship was making considerable water..." The ship was leaking, and a kind of deadly domino effect was soon in operation: when the water came in, it wet the coal, which made it useless for fir-

ing the boilers. When the fires in the boilers were extinguished, the *Central America's* huge steam engines stopped. The pumps, which relied upon the engines for power, were likewise rendered useless.

As the situation worsened, Captain Herndon ordered all the men on board, passengers as well as crewmen, to go to work bailing out the ship.

Up above, the deck crew battled with the storm, fighting desperately to right the ship and keep it on course. Young Second Officer James Frazer reported that the storm spencer (the strongest and heaviest of all the sails on board)

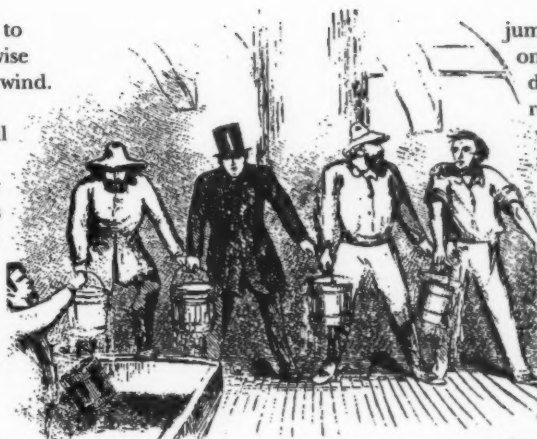
had been set—but was blown to pieces. Other sails were likewise blown to shreds by the fierce wind.

The men continued working all day Friday, and all night long.

Saturday, September 12th, brought mixed feelings of relief and dread. "Shortly after daybreak on Saturday morning," Judge Alonzo C. Monson relates: "the clouds cleared away somewhat, and the passengers and crew felt greatly encouraged." Captain Herndon was not encouraged, however, despite this slight improvement in the weather, as the Judge soon learned. "Captain Herndon told me then that there was no hope for us unless the storm abated soon or some vessel hove in sight."

But then, at noon, there was a glimmer of hope. "On Saturday, at about 12 o'clock, when we had about given up hope of preservation," said Virginia Birch, "a brig was seen some little distance from us, and she rapidly drew toward us." It was the small brig *Marine*, of Boston, commanded by Captain Hiram Burt, with a crew of four.

Captain Herndon ordered the lifeboats launched, and the women and children were lowered by ropes from the *Central America's* deck down into the boats. All the 31 women on board, along with 28 of the 29 children, were saved by the *Marine*. A 12-year old Peruvian boy was lost. Also saved were 19 crewmen (most of whom rowed the lifeboats) and 22 male passengers. Hundreds of men



were left on the steamer.

That evening, after the women and children were safe, the men on the sinking *Central America* began to prepare for the worst. Life jackets were made available to all, and many men built rafts and collected other materials to help keep themselves afloat.

Thomas Badger described the scene. "At 10 minutes of 8 o'clock Captain Herndon took position on the wheel-house with his second officer and fired rockets downward, the usual signal, that we were sinking rapidly."

"Now the vessel gave three lurches, some of the passengers jumping off at each lurch," said Oliver P. Manlove. "Those who

jumped off at the first and second lurches swam off to some distance. But the great mass remained on deck until the vessel went down, which was a minute or two afterwards."

At 8 o'clock that night, September 12, 1857, the *Central America* sank. The men remaining on board were drawn down deep by the suction of the sinking of the ship, and when they returned to the surface the scene that greeted them was horrifying. "Men, some holding planks,

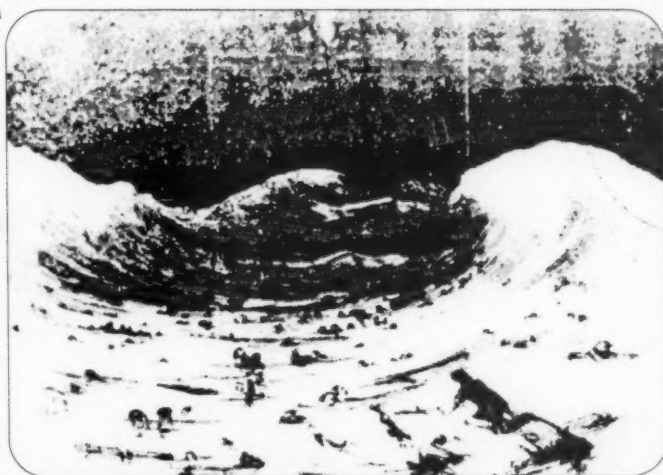
and others without anything, were tossed about through the sea for a great space, and appeared to me like so many corks," said B. M. Lee. "The cries of despair which were uttered by all faintly reached me. I could not describe my feelings at this awful moment."

Thomas Badger reported: "In 10 minutes not less probably than three hundred had sunk to rise no more, whilst myself and others who had succeeded in holding on to some means of support were scattered over the dark and dreary ocean, floating off with the tide."

The men floated for hours in the darkness, sometimes in groups, sometimes alone.

Not far away was the Norwegian bark *Ellen*. At about 1 a.m. Captain Anders Johnsen suddenly realized he was hearing voices from the dark night. "On trying to discover where they proceeded from," he said, "I discovered that I was in the midst of people who had been shipwrecked."

By 9 o'clock the next morning, about 50 men had been rescued by the *Ellen*.



The *Marine* and the *Ellen* sailed off to Norfolk, Virginia, with their survivors. Addie and Ansel Easton would be reunited soon, as would Virginia and Billy Birch, and Thomas and Jane Badger. All the men and women quoted here were rescued, of course—and later told their stories to the newspapers.

After 8 days and 20 hours of incredible suffering, three more *Central America* survivors

were rescued. They had drifted over 400 miles northeast of the sinking, in one of the *Central America*'s lifeboats, and were picked up by the British brig *Mary*.

These three men were the last survivors. As one of the newspapers phrased it: "The exact number of the saved and lost of the steamer *Central America* will probably never be known in this world." Nevertheless, we can estimate: 425 lost, 153 saved. Among those lost in the disaster was Cdr. William Lewis Herndon.

Accounts of the hurricane which sank the *S. S. Central America* are contained in the newspapers of that

time, particularly *The New York Daily Tribune*, *The New York Herald*, *The Charleston Daily Courier* and *The Commercial of Wilmington*, NC. These



papers featured headlines such as:

The Hurricane at the South

Tremendous Gale at the South

The Damage Done by the Gale

No Intelligence of the Central America

The newspapers described the hurricane as being the most violent in recent years. It was most severely felt near Cape Hatteras on September 9th and 10th and at Wilmington, NC on the 11th and 12th. A complete description of the storm can be found in *Hurricane Alley*, which can be found on page 49 of this issue.

THE CAPTAIN—WILLIAM LEWIS HERNDON



Lestie's

"Captain Herndon behaved nobly throughout, and was standing near me on the hurricane deck when she went down. He sank, however, to rise no more, leaving a name to be honored among the heroes of the sea." — survivor Oliver Manlove

Captain William Lewis Herndon entered the Navy in 1828. He served during the Mexican-American War and also worked for 3 years at the U.S. Naval Observatory. There, he worked with his brother-in-law, Lt. Matthew Fontaine Maury, Director of the observatory, who was later to become known as "the father of modern oceanography." Maury was best known for his ocean wind and current charts, which revolutionized navigation and shipping. Herndon worked alongside him in this monumental project. Herndon was given a special assignment to explore the Amazon River in 1851-52 and the results were eventually published in a very popular book entitled *Exploration of the Valley of the Amazon*. One reader of the book was a young man name Samuel L. Clements, who, years later (when he was known as Mark Twain), described the reading of Herndon's book as one of the turning points of his life. Some scholars have suggested that Twain's *Life on the Mississippi* was, in part, inspired by Herndon's book.

During the terrible hours before the sinking

of the *Central America*, Commander Herndon demonstrated a nobility and courage that made him a national hero. He was commended throughout the country for his orderly rescue of the women and children, his maintenance of discipline aboard ship and his personal courage in remaining with his ship to the last.

Commander Herndon was survived by his wife, Frances Hansbrough Herndon, and one daughter, Ellen Lewis Herndon—who later became the wife of Chester A. Arthur. She died, however, before he became president.

The town of Herndon, Virginia, is named after him. The Herndon Depot Museum houses a model of the *Central America* and numerous other items related to Commander Herndon and the steamship. Various items from the WWII Navy Destroyer *U.S.S. Herndon* are on display at the museum as well. In 1860 a monument to Commander Herndon's memory was erected at the U.S. Naval Academy in Annapolis. He is the only peacetime hero to be honored at the Academy with a monument in his name. The plaque on it reads: "Commander William Lewis Herndon, 1813-1857, naval officer, explorer, merchant captain. In command of the *Central America*, home-bound with California goldseekers, Captain Herndon lost his life in a gallant effort to save ship and lives, during a cyclone off Hatteras, September 12, 1857.

'Forgetful of Self, in his death he added a new glory to the annals of the sea'— Maury"

(Portrait courtesy of U.S. Naval Academy Museum.)



CENTRAL AMERICA SURVIVORS



Leslie's

Virginia and William "Billy" Birch were on their honeymoon. They were married on the 19th of August—the day before they left San Francisco. Billy Birch was a famous minstrel comedian and singer. At the time of the sinking he was on his way to perform with Bryant's Minstrels of New York. According to *Frank Leslie's Illustrated Newspaper* (October 3, 1857), Billy continued to entertain even while clinging with a number of others to a floating hatch window after the ship went down. His bride was described by the *New-York Daily Tribune* on September 21, 1857 as: "young, petite in form, and in personal appearance very attractive; added to this, she is possessed of a lively vivacity which renders her very interesting in conversation." However, the *San Francisco Evening Bulletin* (October 24, 1857), had this to say about her: "Many of our readers may not be aware that [Virginia Birch] is 'Jenny French,' a notoriously bad character of this city, to whom is attributed the murder of the German by Backus, and his sentence to the State prison—for it was to resent a supposed insult to this woman that the murder was committed."

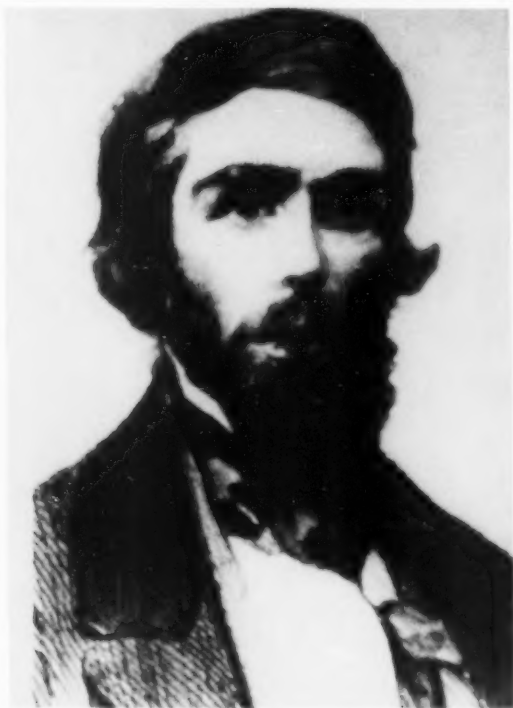
Another honeymoon couple were Ansel and Addie Easton, married on August 20, 1857—the same day they left San Francisco on the *Sonora*. Addie, like the other women, left the *Central America* for the *Marine*—believing that her husband would soon follow. He was not in any of the lifeboats, however. Describing her feelings as she sat alone, Addie says: "Suddenly a rocket shot out obliquely, the lights disap-

**SAN FRANCISCO MINSTRELS
NEW OPERA HOUSE!**
BROADWAY CORNER OF 29th STREET
Opposite the Sturtevant and Gilsey Hotels

GREAT SUCCESS
MONDAY, SEPT. 13th, 1875.

BIRCH, WAMBOLD & BACKUS!
SAN FRANCISCO
MINSTRELS
WITH THE FOLLOWING DISTINGUISHED ARTISTS
D. S. Wambold, C. Rudolph, C. Waide,
J. A. Barney, A. H. Pelham.

JOHNSON AND POWERS
W. S. Mullaly, J. H. Ross, J. G. Withers,
A. Bent, J. Morelli, W. Blakeney, W. Schwab.
BILLY CARTER.
THE GREAT RICARDO
AND THE FAMOUS SONS OF MOSES
Add Ryman, Billy Birch & Charley Backus



Alexander Grant (left), John Tice (right) and George Dawson (below) were all rescued by the English brig *Mary*, 9 days after the sinking. These photographs, by the Meade Brothers, appeared in Frank Leslie's *Illustrated Newspaper*. The poster of the Billy Birch minstrel show was provided by the California Historical Society.



peared beneath the waves, and all the world grew dark for me." Ansel, however, did survive and was picked up by the *Ellen* after 8 hours in the sea. (In an interesting sidelight, noted photographer Ansel Adams was named for their son Ansel Mills Easton. Adams' full name was Ansel Easton Adams.)

Alonzo Castle Monson was 36 years old at the time of the disaster. Brother-in-law of a former Supreme Court Judge, he had graduated from Yale and Columbia University Law School, and had been a judge in Sacramento County but was returning home to live in New York. He had apparently made the trip several times before, and was a good friend of Captain Herndon's. According to the *San Francisco Alta* (August 4, 1857), "No more capable or efficient judge ever sat upon the bench in California." Judge Monson also "sporting to the limit," according to his *San Francisco Bee* obituary (January 3, 1902), having once lost all his money, and his house, in an historic poker game. Judge Monson was able to find a place in one of the lifeboats, a fact that was sarcastically noted in several newspaper accounts.

Captain Badger, sailing with his wife Jane, was on his third trip on the *Central America*. Arriving in San Francisco in 1849, he was captain of the *Jane A. Falkenberg*, which regularly sailed between San Francis-

co and Oregon. He stood by Captain Herndon as the ship sank and assisted him in many ways during the tragedy. Badger lost a large amount of treasure in the disaster. His wife couldn't take a satchel full of gold pieces worth \$16,500 so he kept it with him. However, it was so heavy that he ended up having to get rid of it as the ship sank. He was eventually picked up by the *Ellen* and reunited with his wife.

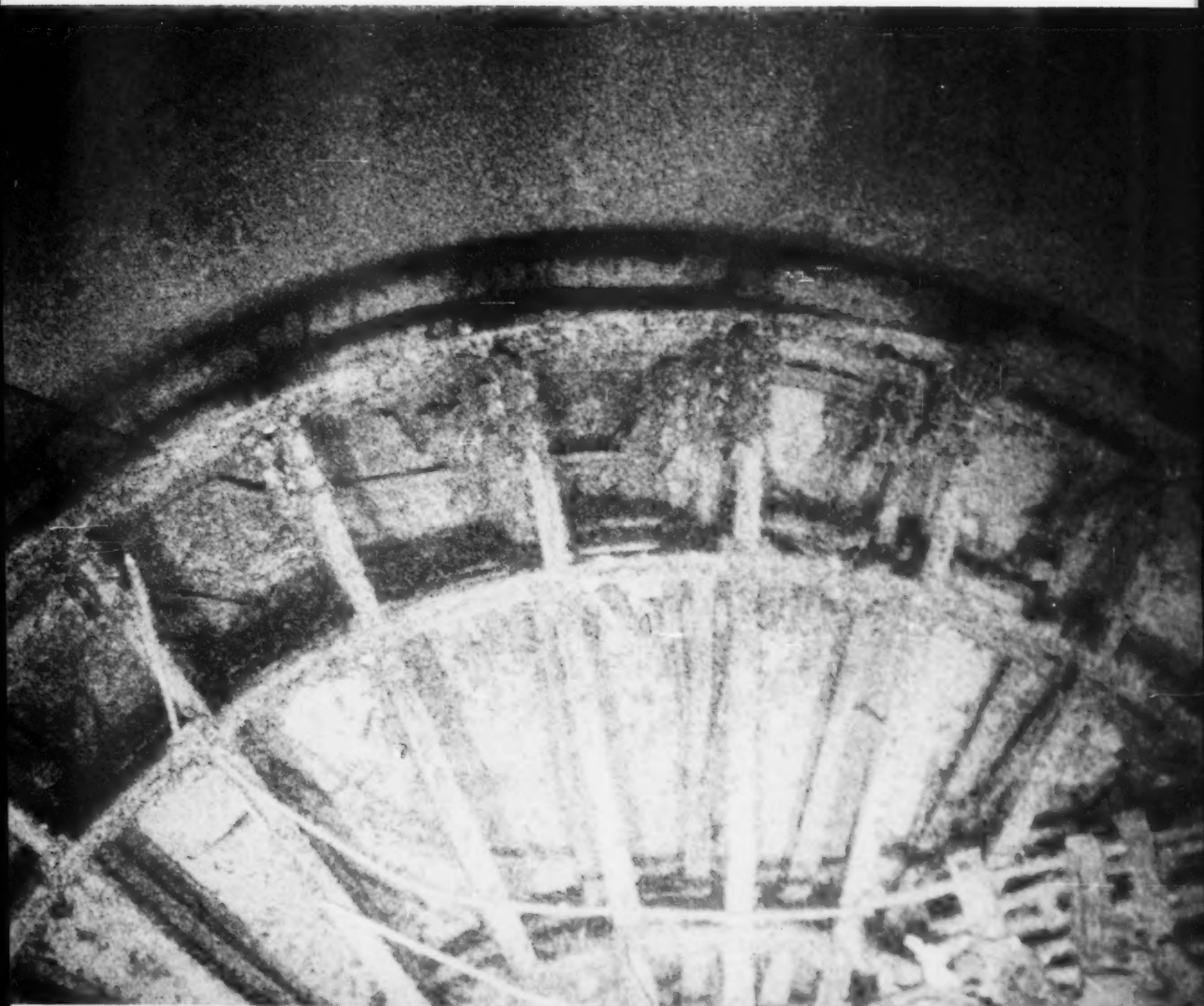


THE S.S. CENTRAL AMERICA EXPEDITION

HURRICANE GOLD

PART II —THE FIND

CHARLES E. HERDENDORF AND JUDY CONRAD
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used by the team included newspaper accounts of the storm and the sinking, lighthouse data and information obtained from other ships in the storm.

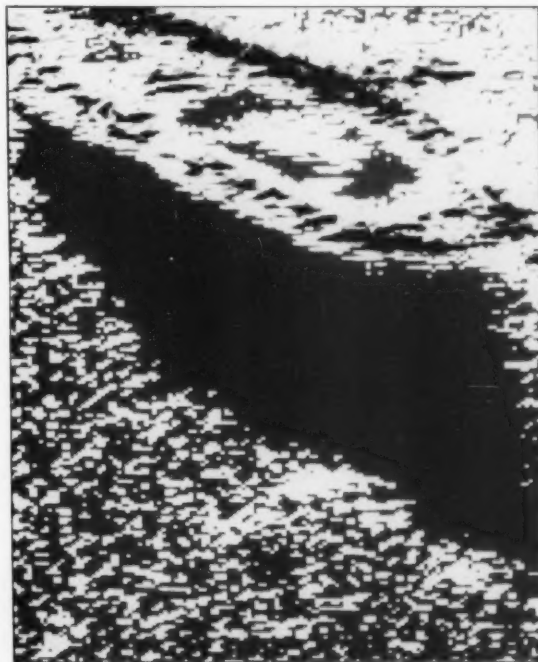
The accounts of some 60 survivors and witnesses to the disaster were used by Bob Evans and Tommy Thompson to compile a data matrix which listed, by observer, the events and conditions, at 3-hour intervals, for the final hours of the voyage. Next, this information was coupled with meteorological and oceanographic data to predict the location of the shipwreck. Computer models helped to determine the effects of the hurricane winds and ocean currents upon the stricken vessel for a series of possible scenarios. For each scenario, computers were programmed to conduct 10,000 experiments to determine the probability of the shipwreck position. The resulting "probability maps" suggested that the wreck was likely to lie within a 1,400 square mile area of the sea floor known as the Blake Ridge.

In the mid-1980s, a small team of engineers and scientists formed the Columbus-America Discovery Group to locate the *S.S. Central America* and recover its valuable cargo. In order to find the ship, years of painstaking historical research and tedious oceanographic surveys were undertaken under the guidance of the project founder and ocean engineer, Tommy Thompson. The first members of his team were Bob Evans, geologist, and Barry Schatz, journalist. They knew that once the *Central America* was located, a submersible would have to be constructed capable of performing complicated tasks in an alien environment—great ocean depths. From the start they recognized that the project would afford many opportunities for wide ranging scientific study, including observations of the marine life and deep-sea environment at the shipwreck site. The eventual success of the *S. S. Central America Expedition* is truly a modern-day adventure which rivals those of the early explorers.

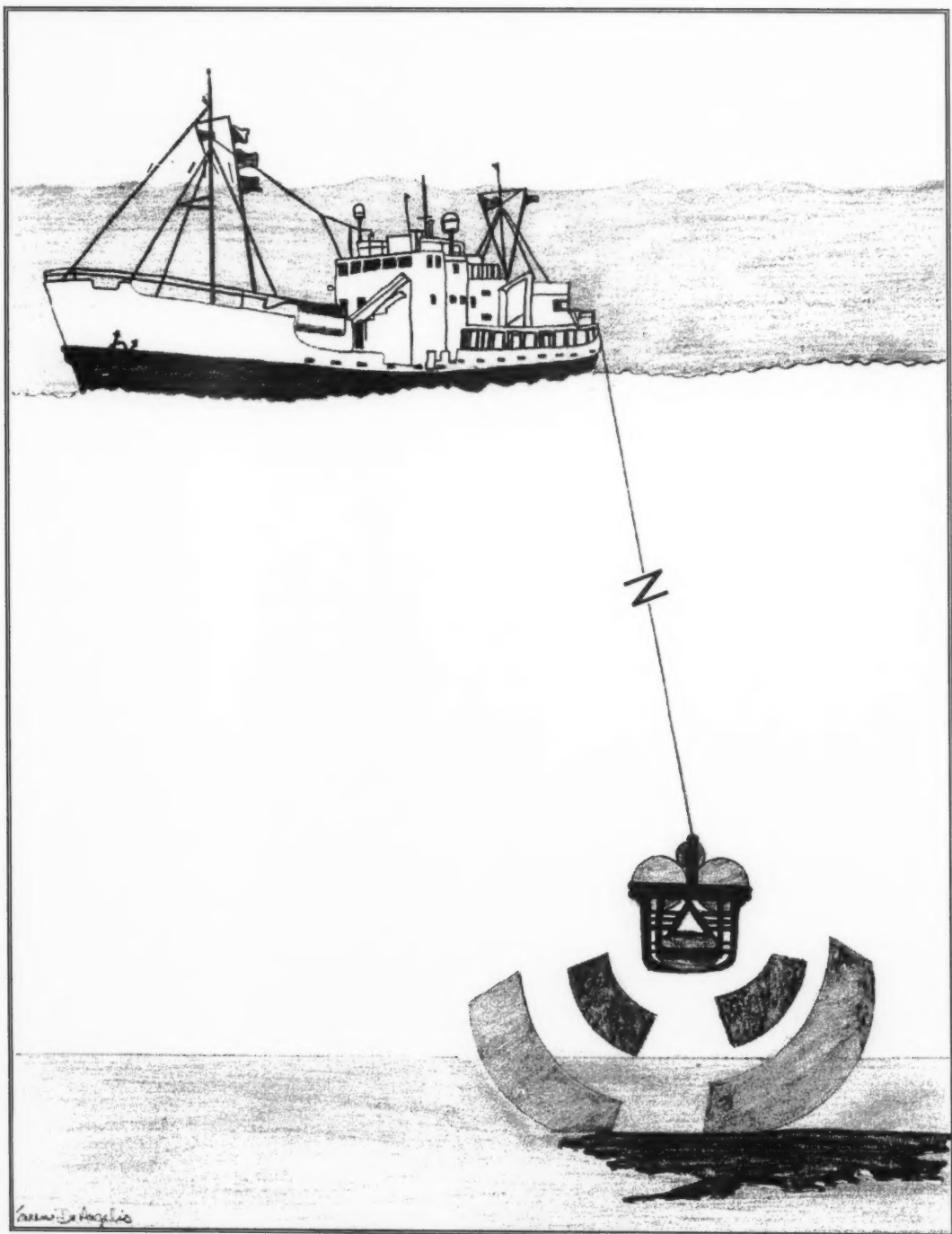
A number of sources were consulted to reconstruct what happened on the *Central America*. Data about the storm was paramount. The various sources of information

Next, Thompson, Evans and Schatz outfitted a chartered ship to survey and image the ocean floor. The key piece of technology in this phase of the project was Sea MARC 1A, a wide-swath, side-scan sonar system that was the most advanced of its kind. This technology grew out of development work in the mid-1970s for ocean bottom mining of manganese nodules. Similar to the radar principle, sonar emits waves, and reads the returning signals. These may be displayed as color images (sonagrams) on a shipboard computer screen. Normally towed 1,500 feet over the bottom, this system can image a three-mile wide swath of the sea floor on a single pass.

Enlisting the services of electronics and navigation experts, the group put to sea with the Sea MARC system in the summer of 1986. The crew hoped that the boilers, engines and other ironworks of the *Central America* would provide a good target, thus proving the accu-



The sight that brought the crew of the Arctic Discover to their feet was the sidewheel of the S.S. Central America (far left). This was definite confirmation that they had found the steamship. The sonar image (left) was one of many vessels located in the graveyard of ships that was scanned while the 1,400-square mile search was underway. Both photographs are © 1989 Columbus-America Discovery Group, Inc.



SEARCHING FOR THE S.S. CENTRAL AMERICA

racy of the historical research and computer analysis. They didn't have to wait long. Cultural deposits were detected between 7,000 and 10,000 feet below on the second pass across the search area. Fighting the urge to stop and explore, Thompson and his group continued the planned search of the entire probability area—a survey which would require 40 grueling days. Subsequent passes produced a series of promising high-resolution sonar images, one with distinct features that might be a side-wheel steamship.

Once a probable location of the shipwreck was determined from the sonagram, the project entered a new phase—construction of a research submersible of revolutionary design and acquisition of a research vessel to serve as a launch platform and control center for the expedition. By 1988, the *R/V Arctic Discoverer* and research submersible *Nemo* had joined the expedition.

While the scientists and engineers in the *Arctic Discoverer's* control room were maneuvering *Nemo* across the monotonously flat seabed, in August of 1988, suddenly the 32-foot diameter sidewheel of the *Central America* loomed ahead. They had found her—the *Central America* was theirs. Unconstrained cries of excitement burst from the scientists and engineers in the control room of the *Arctic Discoverer*, a mile and a half above the shipwreck.

In November, after discovering the *Central America*, but before reconnaissance surveys could be completed or any of the treasure recovered, Tropical Storm Keith forced the expedition to be terminated for the season. The long winter wait began and it wasn't until September 1989 that a major deposit of gold had been located. The site looked much like a Hollywood set with gold bars strewn over the collapsed decks and gold coins literally dripping from the ship's

The Sea MARC 1A (left) sweeps the bottom looking for tell-tale sonar images. What looks like a Hollywood set (right) is the scene at nearly 8,000 feet below the sea surface at the site of the shipwreck of the S.S. Central America. Photograph © 1991 Columbus-America Discovery Group, Inc.



timbers. Once again weather entered the picture. In late September, Hurricane Hugo roared through the West Indies following a track similar to the 1857 cyclone. Captain Bill Burlingham had been tracking the storm for days. Finally on September 19, he announced that the storm was moving at nearly 20 knots and heading in their direction. Noting that their cruising speed was only about half that of the storm, Bill decided to head for a safe harbor in North Carolina. The *Arctic Discoverer* docked in the early hours of September 22 and that evening the storm passed inland to the south, at Charleston, but the crew still experienced winds of 60 knots. They returned to the site 5 days later and had several suc-

cessful dives. However, the autumn storm patterns were beginning, so they soon terminated the season. On October 5, 1989 they entered the port of Norfolk, Virginia with over a ton of gold on board.

The *Central America* sank in the North Atlantic near the intersection of latitude 32°N and longitude 77°W—east of the main track of the Gulf Stream at the edge of the Sargasso Sea. This is where the margin of the North American continent drops off abruptly along the Blake Escarpment. Water depths here range from 6,600 to 11,000 feet. Calculations of the sinking dynamics indicate that the *Central America* sank to the bottom of the sea in about 18 minutes, landing at a speed of 5 m.p.h. On a low gen-



*Hurricane Hugo, (left) like the original hurricane of 1857, played a key role in the shipwreck story. Hugo closed in on the site in September of 1989 and forced the expedition to retreat to the shelter of the North Carolina coast, an option that was not afforded the *Central America* (NESDIS Photo).*

NEMO AND THE ARCTIC DISCOVERER



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The *R/V Arctic Discoverer* was launched as the Canadian Coast Guard Ship *A. T. Cameron* in June 1958 at the yards of Milne, Gilmore and German Ltd. in Montreal, Quebec. The vessel was designed along the lines of a typical British trawler of that period, but heavier plating and framing were added to render it serviceable for the ice conditions in the northern North Atlantic. She was named for Dr. Alexander Thomas Cameron, one of Canada's foremost fisheries scientists of the early 1900s. For 25 years the *Cameron* was operated by the Fisheries Research Board of Canada as a side trawler to assess the strength of fish stocks off Newfoundland and to collect oceanographic data.

The advent and wide use of stern trawlers hastened the end of the *Cameron's* service in fisheries research. In 1985, she was sold to Alexander Bay Shipping Ltd., of Glovertown, Newfoundland and renamed the *M/V Arctic Ranger*. She was intended to be employed in the annual white coat seal fishery on the northern ice floes. In the mid-1980s a successful anti-seal hunt campaign by Greenpeace and other animal welfare groups drastically reduced the market demand for seal pelts. Thus, it was again sold, this time to the Columbus-America Discovery Group of Columbus, Ohio. Under its new name, the *R/V Arctic Discoverer* has participated for four seasons in the exploration and recovery of the *S. S. Central America*.

The *Arctic Discoverer* is captained by Bill Burlingham of New York. She is 180' LOA x 33' x 14.5' draft with a gross tonnage of 753. The main engine is an Alpha 1000/1100 BHP (V.P. Propeller), capable of a

cruising speed of 12-13 knots @ 305 rpm. Auxiliary engines include bow and stern outboard thrusters with 360° turning capability. The thrusters, which are linked to the satellite navigation system, are used to maintain position over the shipwreck site, nearly 8,000 feet below. Other specialized facilities include an articulating crane designed to launch and recover a 6-ton submersible and a "high-tech" control room with 17 video screens to monitor the sea floor and the submersible. The *Arctic Discoverer* is an active participant in the National Weather Service Voluntary Observing Ship Program.

The real star of the expedition is the 12,000 pound research submersible, *Nemo*. Constructed in Columbus, Ohio, during 1987-88, *Nemo* was designed to conduct delicate operations in extreme cold and pressure and in complex site conditions. With robotic arms and precision tactile manipulators, *Nemo* can retrieve items smaller than a dime, but also has the heft to bring up a 300 pound ship's bell. Other specialized tools include a hydraulic dustpan, a water jet and a suction picker to recover fragile artifacts as well as a silicone injection system to solidify piles of gold coins, so that several hundred coins can be recovered in a single block. *Nemo* has drawers, which are hydraulically operated, for transporting tools and experiments to the ocean floor and for recovering artifacts and scientific specimens. *Nemo's* stereo cameras, powerful illuminators and five camera booms for multiple perspectives are used to record the entire deep-sea investigation. Three-dimensional images are transmitted via a fiber optic cable to the surface allowing the engineers and scientists directing the dive from the control room to have "telepresence" and excellent underwater depth perception.

Precision navigation of *Nemo* is controlled through a network of sonar transponders positioned near the ocean bottom around the perimeter of the shipwreck site. They form an acoustical grid which allows the scientists to carefully determine the position of artifacts. *Nemo's* performance has improved through the years. In 1990, the submersible's endurance surpassed that of her crew—the longest dive lasted over 3 days!

tly sloping ridge the wreck of the *Central America* rests at a depth of nearly 8,000 feet. The ocean floor at this depth is a harsh environment. No sunlight reaches the bottom and deep-sea creatures must cope with total darkness, cold temperatures (a few degrees above freezing), and immense pressures (over 3,600 pounds per square inch or 240 times the pressure at the ocean's surface). Slowly, hardy animals of the deep colonized the wreck and eventually a diverse biological community was formed on this deep-sea oasis. For thirteen decades the remains of the *Central America* thus rested quietly on the ocean floor waiting to be discovered. The description of one deep-sea dive in 1990 indicates the type of scientific investigations and experiments being conducted at the wreck site.

In early September of 1990, the crew launched *Nemo* from the deck of the *Arctic Discoverer*, sending it on a dive, which would last for over 24 hours, 21 of those being spent on the ocean floor. The control team consisted of six scientists and technicians, each responsible for a specific aspect of the expedition. The dive objectives were to establish a science experiment station on the wreck and to observe and sample the deep-sea marine life. This dive provided a particularly good opportunity to observe the present condition of



the ship and to speculate on how it must have looked before sinking. To place it in perspective, the original ship can be likened to a narrow, 4-story building about as long as a football field. Midway along the hull of the structure would have stood the most prominent features, the port and starboard paddlewheels. The bow was sharply pointed and the stern was much more blunt with gently rounded corners. Viewing her now, we see collapsed timbers and piles of coal teeming

with marine life.

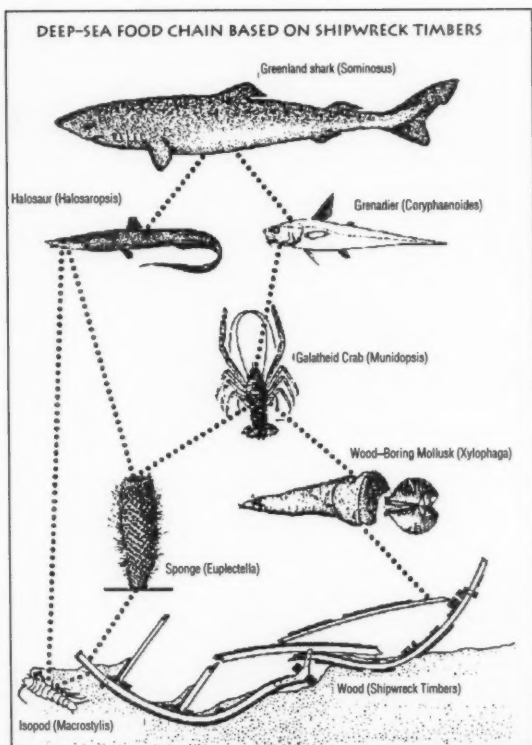
At the science experiment station, 50 kilograms of grouper carcasses were stacked on the seabed to attract scavenger and predator animals. This was supplemented by several trays filled with fish meal and cracked corn. Next, six 4" x 4" oak and pine posts were set in the sediment to study the rate of shipworm infestation. Burrowing by these deep-sea clams is thought to be the process responsible for much of the disintegration of the ship's timbers.

In the early morning hours, as *Nemo* was lifting off from the science experiment station, one of the most startling observations occurred when a monstrous 20-foot long Greenland shark (*Somniosus microcephalus*) cruised through the station, brushed against one of *Nemo*'s camera booms and moved off toward the pile of fish carcasses. Approximately 50 monkey-faced eels had been seen feeding on the carcasses, in their peculiar whirling manner, shortly before the shark

A brisingid starfish is found among the timbers (right) of the wreck, while a Greenland Shark (above) is caught by Nemo's video camera at a depth that was surprising to everyone aboard, as well as the experts on land. (Both photographs ©1990 Columbus-America Discovery Group, Inc.)



An anchor chain of the S.S. *Central America* (below) is draped over a large water tank. It has become encrusted over the years and some of the marine animals that call it home include gorgonian coral and sponges. (Photograph © 1989 Columbus-America Discovery Group, Inc.) The wreck created a biological colony. Scientists are studying this community to try and discover among other things how these organisms found the wreck site, which evidently represents an oasis in the middle of an ocean desert.

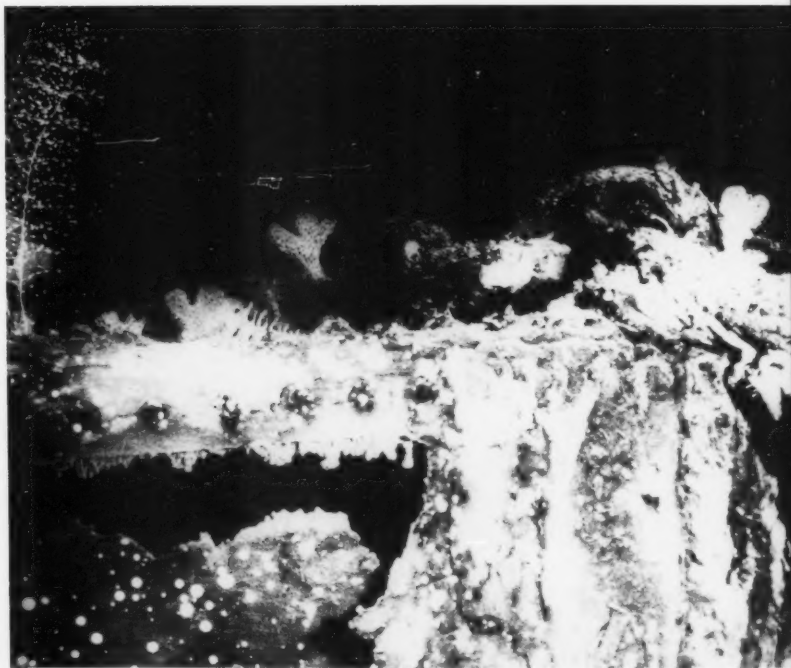


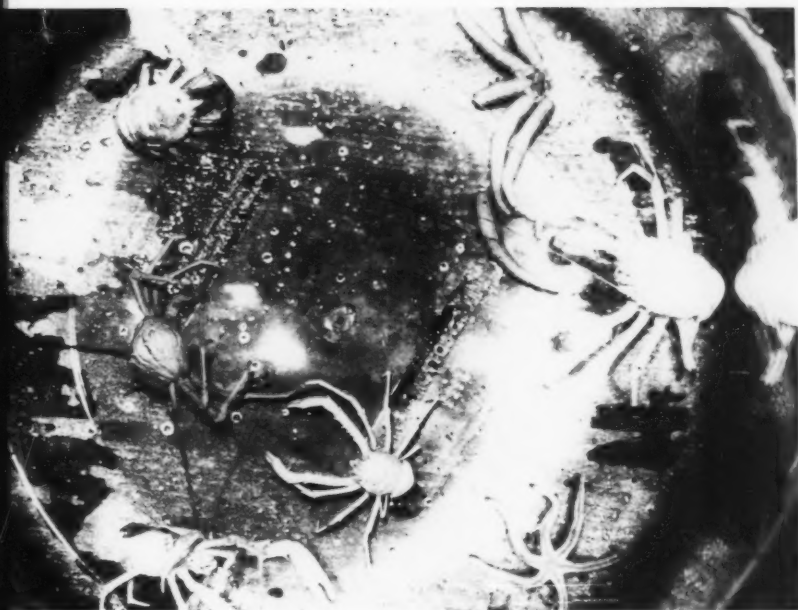
The collection of specimens was accomplished by simply gathering benthic forms (bottom-dwellers) with *Nemo's* manipulator and placing them in a 20-liter polystyrene container that was then placed in a drawer. Perhaps the most difficult part of the operation was snapping a water-tight lid on the container, but this proved to be an effective way to transport specimens across the water-air interface without damaging them from shock waves as the submersible bobbed in and out of the sea during vehicle recovery.

The shipwreck lies in a desert of minute shells that have rained down from the ocean's surface. Thus it provides an unusual substrate, a biological oasis among the wooden timbers, coal and metalworks, which has been colonized by a diverse group of bizarre deep-sea animals. The dominant members of the community are hexactinellid (glass) sponges, gor-

appeared. Later that morning when *Nemo* returned to the experiment station, the camera revealed that only a few eels remained and that the fish meal trays were nowhere to be found. Later it was learned that Greenland sharks eat almost anything, including reindeer that venture too far out on Arctic ice. The sighting from *Nemo* was about 1,000 miles farther south and over 3,000 feet deeper than any earlier record for this shark.

This exciting and intellectually stimulating dimension of the S.S. *Central America* Expedition is known as the Adjunct Science Program. This program is a network of over 50 eminent scientists and scholars from academic institutions throughout North America who are studying oceanographic data, marine specimens and historic artifacts obtained from the deep at the shipwreck site.





gonian corals, sea anemones, polychaete worms, pholadid clams, amphipods, barnacles, galatheid crabs and several kinds of deep-sea fishes. The colors of these animals are unexpectedly brilliant, such as pink and gold corals, vermillion starfish, orange and yellow anemones, purple sea cucumbers, red shrimp and stark white crinoids. *Nemo's* cameras have captured the behavior of many of these animals, including the graceful swimming of feather stars, the mating ritual of brisingids and arm casting of these sea stars when stressed, and the browsing of ophidiid fishes among the piles of gold coins. Many of these animals have never

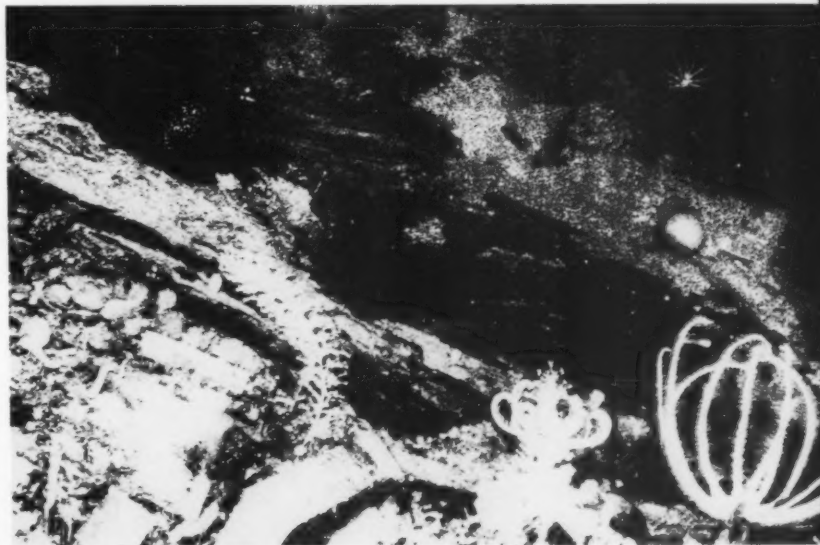
been observed alive before and some of them, particularly some of the sponges, are very likely species new to science. Because deep-sea sponges produce noxious chemicals to ward off predators, they are excellent targets for biochemical research. Specimens of these deli-



cate animals have been recovered for anti-tumor testing at universities in California and Ohio.

The 1990 season ended with more gold and silver treasure being recovered as well as a number of other fascinating artifacts. The biological treasures captured in vivid color on videotape were rewarding to the scientists. In the end, hurricanes and stormy fall weather drove the team from the site in mid-October. Plans for the 1991 season call for continued exploration and recovery of the site as well as ecological investigations of the amazing biological oasis created by the shipwreck.

A biological as well as metallic bonanza is being harvested at the wreck site. Above, crabs and starfish are collected in traps, while Nemo's manipulator arm (above, right) places a glass sponge in a plastic pail. Gold and animals coexist among the timbers (right). These photographs are © 1990 Columbus-America Discovery Group, Inc.



The Central America treasure is impressive—thousands of gold coins and hundreds of gold bars, as well as gold dust, flakes and nuggets. Sizeable quantities of the nuggets were recovered with a new device called a "SeaVac," which vacuums the sea floor, retaining dense material such as gold and by-passing the lighter shells which form the ocean bottom. One outstanding recovery was a large gold nugget encrusted with quartz crystals, most likely eroded from a California hillside and deposited in a stream bed shortly before a lucky miner found it. The bars and coins are fascinating not only for their beauty, but for their historic interest as well. The bars (more properly, gold ingots) range from 5 ounces to 754 ounces—almost 63 pounds! This is the largest gold ingot known to have been recovered from a shipwreck.

Many of the gold coins retrieved from the shipwreck are 1857-S twenty dollar gold pieces (known as double eagles). One of the more remarkable finds was "the tower," a neatly stacked pile of 300 double eagles. Originally these filled a container which has been disintegrated by shipworms. Salts from the sea water and iron oxides from the rusting steam engines have lightly coated the coins of the tower, so that the tower has withstood the forces of the gentle currents. The entire tower was recov-



TREASURE FROM THE DEPTHS



ered intact using a silicone compound which was injected into a mold. Rare Fifty-dollar gold Pioneer coins (right) were also found.

A leather-bound steamer trunk (left) from the 1850s lies on a soft pleropod and foraminiferal ooze. The trunk has been colonized by brilliant orange sea anemones, plant-like whorls of gorgonian coral, and lacy glass sponges. A small yellow sea anemone can be seen on the right side of the trunk's top and near it a white feather star has attached itself to a coral stalk.

The steamer trunk of Adeline and Ansel Ives Easton (above) yielded some real surprises, one of which was a well-preserved copy of the July 20, 1857, *New York News* (page 23), which was wrapped around a shirt. Clothes and

personal items were also astonishingly intact as well (below, right). The Eastons' clothing is being studied in detail by Associate Professor Kathryn Jakes of The Ohio State University Department of Textiles and Clothing. Lucy Sibley, Chairman of that department, said the fabrics are in "amazingly good shape" for the most part, with the thread intact and even dye still present in the prints. "They were small people by today's standards, from the size of the clothes. She was obviously a little tiny thing," said Bob Evans. "The waist of her gowns is less than 20 inches."

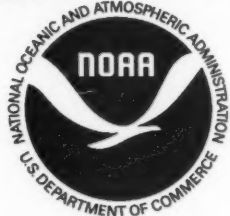
Other recovered items include a glazed ceramic jar with the legend "Highly Perfumed Bear's Grease for Beautifying The Hair." Also found in the trunk were a brace of pistols, possibly derringers or dueling pistols. The barrels were rusted away, but the balls were almost $\frac{1}{4}$ inches in diameter.

Gold is not the only treasure at the bottom of the sea. There is a time capsule contained in the artifacts, which are personal effects that link the Columbus-America Discovery Group to the men and women of pre-Civil War America, where miners could become millionaires overnight and manifest destiny seemed a reality.

(Photographs © 1990 Columbus-America Discovery Group, Inc.)



SEAS III and BEYOND



Patrick McHugh
National Ocean Service

In this era of personal computers, shipboard weather observers should not be left out in the cold.

In addition, increasing competition is resulting in ship owners retaining fewer personnel, who are being asked to perform a greater range of functions.

The SEAS Solution

One solution, in the area of weather reporting, may lie in the use of SEAS (Shipboard Environmental [Data] Acquisition System). These hi-tech units are presently based on the popular IBM Personal Computer (PC). The key to the success of this system is the menu-driven software that prompts the user for all the data needed, reminding him of any options that are available. The data are then automatically transmitted via GOES (the Geostationary Operational Environmental Satellite) to a NOAA receiving station.

The SEAS Office is now developing a next-generation SEAS system that should be completed by fall, 1992. Parts of the system are already in use, specifically an IBM 80286-compatible PC with color monitor. Other hardware enhance-



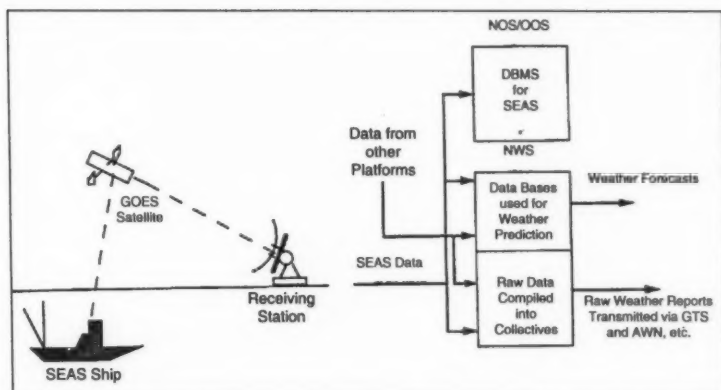
SEAS III units have met the requirements for full operational use aboard ships cooperating in the U.S. Voluntary Observing Ship pro-

gram. These units along with 30 SEAS II units comprise a total of 118 installations.

ments planned include a PC board for digitizing XBT probe data (now performed by a separate XBT controller), a Global Positioning System PC board to register latitude and longitude automatically, and the capability to transmit data via INMARSAT Standard C.

As an alternative to transmission via the GOES satellite, some ship owners are considering the installation of COMSAT Maritime Services' Standard C ship

terminals aboard ships for general 2-way communication as well as the transmission of SEAS and other data. The ship's computer or telex machine feeds messages into the terminal, which transmits via the INMARSAT satellite to a COMSAT coast earth station in the U.S. The messages are relayed via private, national, or international networks to their destinations. In the opposite direction, messages are sent via the same channels.



Commercial satellite capability will mean that any ocean-going vessel that has a PC and a low-cost Standard C transmitter will be able to function as a SEAS VOS reporter with just a little training and installation of the latest SEAS software.

NOAA intends to install SEAS technology on a large percentage of the ships cooperating in the U.S. VOS Program. Discussions with ship owners and representatives of the U.S. Maritime Administration have led to a redesign of the SEAS hardware and software to allow data to be quality controlled prior to transmission, greater display capability aboard ships with high resolution monitors, and even more user-friendly software. In the future, according to Christopher Noe, SEAS Program Director, "Every effort will be made to automate shipboard acquisition and recording and reduce unnecessary workload."

The Early Days

SEAS was developed in the late 1970s to bring the cooperating U.S. Voluntary Observing Ships (VOS) Program into the computer age. The highlight of the system was the use of GOES to relay the data directly to NOAA's receiving station at Wallops Island, VA. This satellite link has several advantages over conventional voice transmis-

sion via ship-to-shore radio including automatic transmission, less susceptibility to noise, and availability of the information in near real time (within minutes).

The first SEAS units used a small Texas Instruments computer terminal connected to a Synergetics transmitter capable of providing an uplink signal to GOES. Weather data were manually keyed into the terminal. At a preset moment, determined by the assigned GOES channel, the clock-operated transmitter sent the data via GOES. This timed operation was necessary because the GOES satellite serves as a relay for all kinds of data platforms and can handle only a limited number of received signals simultaneously. These SEAS I units success-



The Captain of the M/V Ferncroft is "pleased with his SEAS," after more than 5 years of continuous operation and more than

fully demonstrated ease of use and feasibility of installation and maintenance aboard cooperating ships.

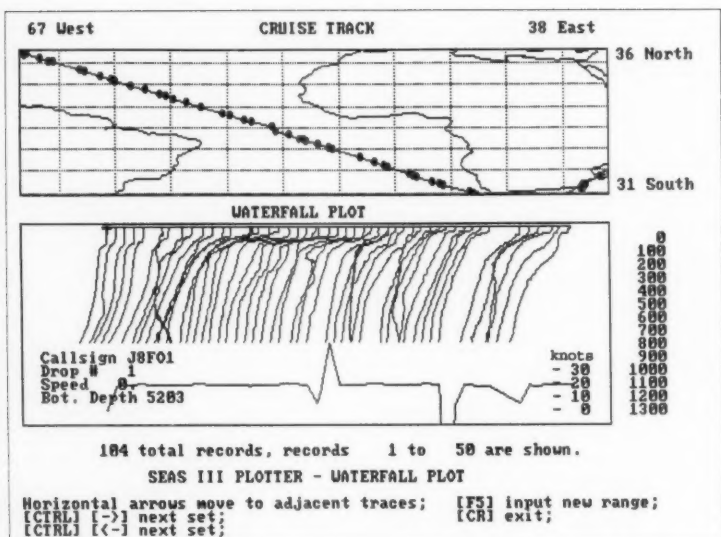
Although about 15 percent of marine meteorological data are provided by VOS ships equipped with SEAS units, most of the global marine meteorological data are still provided through conventional radio communication from the other VOS ships.

NOAA uses these observations, along with land station data, as input to mathematical models that paint a hemispheric weather picture. This analysis is performed by the National Weather Service (NWS) four times daily at the synoptic hours of 0000, 0600, 1200 and 1800 UTC and enable weather forecasts to be made for the high seas, coastal and inland areas. Data received from the VOS Program are shared with scientists around the globe and exchanged for marine data obtained by other international programs.

The Recent Past

In the early 1980s the National Ocean Service (NOS) was given the responsibility for further development of the SEAS units and their deployment. Vincent Zegowitz, who is presently the NWS

5,000 observations successfully transmitted. This is a SEAS II unit.



SEAS field personnel are provided with SEASPLOT software, which allows them to test the data disk used to store XBT data over an entire cruise. Above are the results of the SEASPLOT program applied to XBT data from the Rosebank. Below is a dot plot map of SEAS weather observations for the quarter ending September, 1990.

Marine Observations Program Leader, installed many of the first SEAS systems aboard NOAA ships and on cooperating commercial vessels. Zegowitz and Steven Cook, who was then with the NOAA National Marine Fisheries Service (NMFS), took steps to improve SEAS units by adding the capability to input data from an XBT probe that was hand-launched from the ship's deck. With this addition, SEAS became a reporter of oceanographic as well as meteorological data. The SEAS II units were designed around a relatively inexpensive microcomputer. Once information was entered into the microcomputer, transmission of data was automatic and under control of the transmitter. Typically this installation consisted of a microcomputer (pre IBM PC); an XBT controller, launcher, and probes (if bathythermographic data were to be collected); a GOES transmitter; and an antenna. There are 30 of these installations still in use aboard ships.

What was really needed

aboard cooperating ships was a microcomputer that the ship's radio operator could easily handle along with his many other duties. Such a system was developed in the mid-1980s by the NOS. These units, designated as SEAS III, have met the requirements for full operational use aboard ships cooperating in the U.S. Voluntary Observing

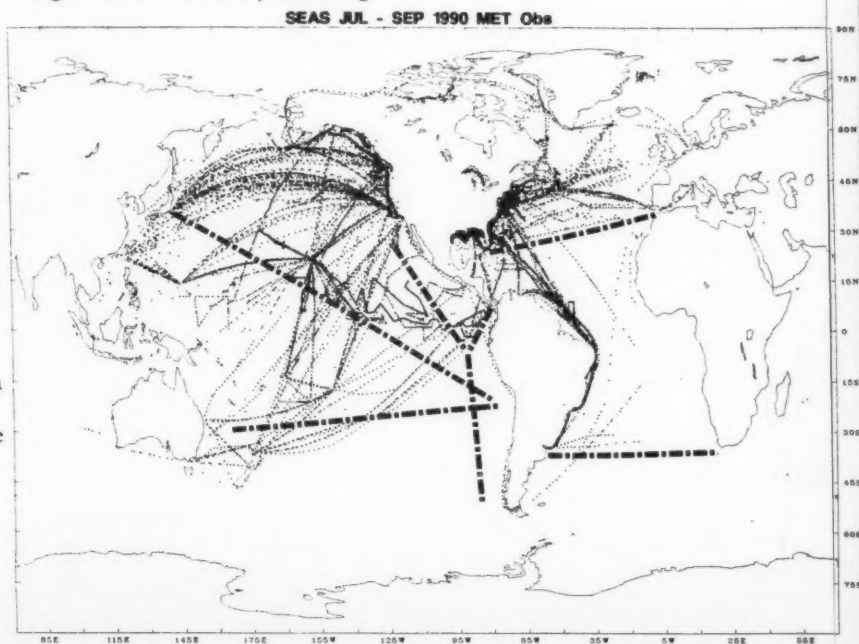
Ship program. Along with the earlier installations, there are now a total of 118 operating units.

Promising Trends

Presently, 65% of SEAS units installed are aboard commercial ships, an increase from about 50% in the mid-1980s. This is a promising trend, since commercial ships are needed on the lesser traveled routes to provide data for a more complete view of oceanographic and meteorological conditions.

During 1990 the three SEAS-equipped vessels operated by Crowley Maritime Corporation were recognized by NOAA as Best Weather Reporters. The *Sea Merchant*, *Sea Lion*, and *Sea Wolf* collected a combined total of 3,533 weather messages.

In the future, a greater number of VOS ships equipped with SEAS technology could provide seafarers, scientists and the general public with a wealth of real-time data for increased knowledge of the marine environment and for improved forecasting of weather.





The M/V Sea Merchant is one of NOAA's top weather reporters and is equipped with a

SEAS III. The 174-meter long container vessel took 1441 observations in 1990.

The Folks In the Field

The people who install and service the SEAS units include: Steven Cook, SEAS Operations Officer in LaJolla, CA, Petty Officer Steven Ranne, U.S. Navy in Monterey, CA, Robert Decker at the Pacific Marine Center in Seattle, WA, James Farrington at the Atlantic Marine Center in Norfolk, VA, Warren Krug at the NOAA Atlantic Oceanographic and Meteorological Laboratory in Miami, FL and Robert Benway at the NOAA Fisheries Laboratory in Narragansett, RI. We are also indebted to the Port Meteorological Officers for their participation in the SEAS program.

Ships wishing to volunteer for the installation of SEAS units should ideally have scheduled stops at a U.S. port so that the equipment can be serviced on a regular basis. Volunteers should be willing to transmit four meteorological observations daily via SEAS.

Contact Christopher Noe for inquiries about any aspect of SEAS. He may be contacted at NOAA Code N/OS1, 6010 Executive Boulevard, Room 925, Rockville, MD 20852/Telephone: (301) 443-8110/ FAX: (301) 443-8208/ OMNET: C. NOE.



Above is the NOS SEAS Staff at Headquarters in Maryland. From left to right: Gary Soneira (SEAS data base), Darren Wright (data analysis), Chris Noe (SEAS Program Manager), Chuck Roman (co-developer of SEAS III), Sammy Moussa (data communications and processing), Geoff French (co-developer of SEAS III), Mike

Szbados (co-developer of SEAS III and Program Manager of NOS's VOS program) and Mike Conolly (SEAS Logistics Coordinator). Not in the photo are John Kundrat (Tracer of lost SEAS data) and Patrick McHugh (writer and editor).



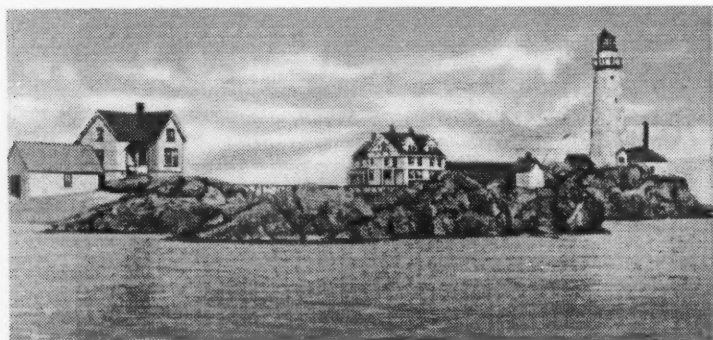
Keeping Boston Light

Elinor DeWire

On September 14, Boston Lighthouse will celebrate its 275th year of service to mariners.

Unlike most lighthouses today, whose birthdays pass in quiet solitude with only spiders and seabirds in attendance, Boston Light will be the centerpiece of a grand celebration.

Not only is it the oldest light station in the country; it's also the only one with keepers on duty. Of the Coast Guard's 37,000 active duty billets, only three are for light-keepers. All three live at Boston Light, and they'll be hosting quite a party when the historic tower turns 275.



Boston Light was the first lighthouse established in America and its light was first lit on September 14, 1716. A tonnage tax of 1 penny per ton on all vessels, except coasters,

The men rotate duty two weeks on and one week off, with two men always at the station. They share many of the same tasks as the old wickies who tended the lighthouse years ago—cleaning and painting; grooming the lawn and keeping the station machinery in order; polishing the 5-ton, second order lens; and reporting the weather.

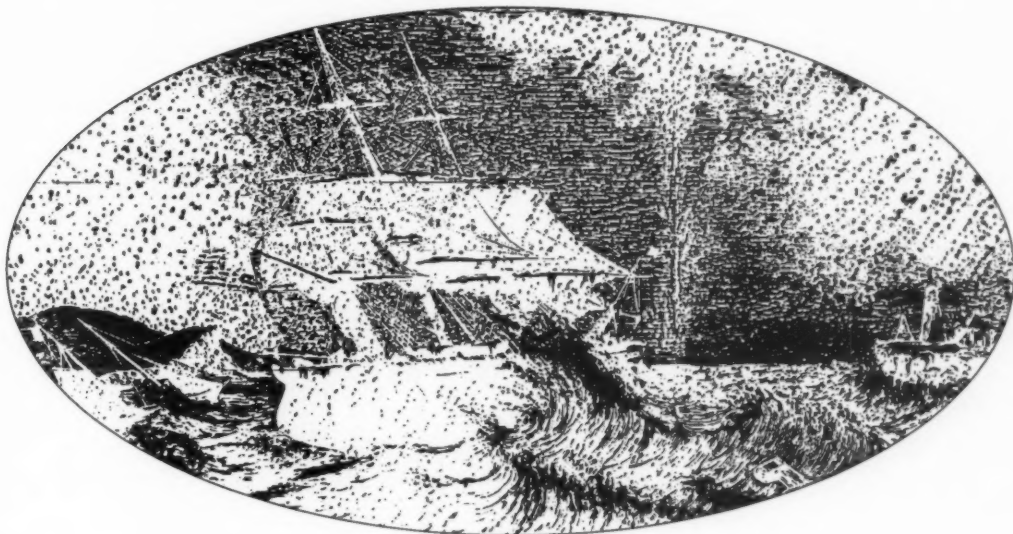
What they don't share with their distant predecessors is the many comforts of modern lighthouse keeping. The station has a TV, VCR and video games. There's a microwave oven in the kitchen, and of course, a telephone and radio.

moving in or out of Boston Harbor, paid for maintaining the light. On June 10, 1790, the Boston Light was ceded to the new Federal Government.

"Lighting up" for the night has been greatly simplified too. Whereas the tower's first keeper had to kindle some fifty tapers on a huge candelabra and remain with them throughout the night, the current head keeper merely flicks a switch in the tower's base and heads off to bed. He's awakened by an alarm if the light fails during the night.

The station fog signal is even less demanding. In 1719 it was a booming cannon fired every half hour in fog. The current signal continually sends out a wire-thin beam of light to measure visibility and turns itself on when its probing beam fails to pierce the air. The keepers regularly fire up the old compressed air foghorns though, since they must serve if the high-tech signal fails.

No women have ever officially served at Boston Light, but many have left their thoughts in the station logbook. Until recently, families were permitted to live on the island, and a number of wives and daughters assisted the official keepers. Lucy Long lived at the lighthouse with her father from 1849 to 1851 and kept a colorful diary of life there. Her romance with harbor pilot, Albert



Off Boston Light

Small, culminated in a proposal of marriage in the tower's lantern.

The only female presently living at Boston Light is a slinky, black cat named Ida Lewis. Her namesake is the intrepid 19th century Rescuer of Lime Rock—the most famous woman lighthouse keeper in America. The feline Ida Lewis lives as comfortably as the three-man crew, but earns her keep. Without her expert ratting and mousing skills, the island would be overrun with rodents.

Ida gets help with furry intruders from Shadwell, a handsome German shepherd. He handles the rats that outsize Ida and amuses himself by barking at seagulls. Cats and dogs are traditional pets at lighthouses. Like the keepers, they are reminders of simpler days when wooden ships plied the waters off Boston and keeping the light was a respected and venerable occupation.

Shadwell's unusual name

also elicits puzzled expressions from visitors. Head keeper Sandy Booth says the animals' names make wonderful conversation topics. Ida's historic sobriquet has already been mentioned. Shadwell is named for a more obscure participant in lighthouse history.

The dog is named for the black slave of the lighthouse's first keeper. George Worthylake and his family lit the beacon for the first time on the night of September 14, 1716, but only a year later tragedy struck. While rowing back to the light from a visit ashore, the boat capsized and Worthylake, his wife, and daughter drowned. Their loyal servant, Shadwell, also died in the frigid November water. The accident so moved a young printer's apprentice, he wrote a poem about it called "Lighthouse Tragedy" and sold copies on the streets of Boston. His name was Benjamin Franklin.

Boston Light's long tenure as a navigational aid is replete with stories of storms, shipwrecks, and rescues, as well as peculiar happen-



Elinor DeWine

Assistant keeper Scott Gamble is seen with Shadwell, the station German Shepherd, named for a black slave who lost his life.



Elinor DeWire

Boston Light is located on the southeast side of Little Brewster Island, about 11 miles out in Boston Harbor. It stands about 102 feet above the water. Boston Harbor is the largest seaport in New England.

Approaching the harbor from the east, the most prominent island is Great Brewster, which is about 0.4 mile northwest of Little Brewster Island.

ings. The original tower was less than 50-feet tall, yet it managed to attract enormous attention, particularly from the Almighty. It was frequently hit by lightning, sometimes with disastrous consequences. Strikes in 1720 and 1751 resulted in fires that consumed all the wooden parts of the tower.

Puritan ethics of the day forbade lightning rods, since it was believed they interfered with heaven's divine strokes. After several devastating hits on Boston Light, however, it was decided Ben Franklin's ingenious lightning rod was in order, for the lofty lighthouse seemed to tempt the powers of heaven a bit too much!

The British accomplished what natural forces could not. The lighthouse became a pawn during the Revolution, alternately flashing

on and off to aid whichever side occupied it. As British troops departed Boston in 1776, they hurled one last blow at the stubborn Americans. Out of spite they blew up Boston Lighthouse, leaving a pile of rubble where the colonies' first sentinel had stood. Historians believe the current tower, built in 1783, contains some of the stones of its tough, old predecessor.

In the mid-nineteenth century, the tower was heightened to its present 98-feet and a spiral, cast-iron stairway was added. It was also made a second-order beacon with the installation of a spanking new French crystal lens, 15-feet high, rotated on a series of small wheels. Its beehive of brass and 336-prisms still requires about 4 hours to clean. The oil lamps that illuminated it a century ago have been replaced by a 1000-watt light-

bulb.

Many keepers have chiseled their names and dates of service into the rocks around the island, and there are several graves there. In November 1861, the square-rigger *Maritana* ran into heavy seas in Massachusetts Bay and approached Boston in a blinding snowstorm. On the morning of the 3d, she sighted Boston Light and headed for it, but wrecked on nearby Shag Rocks. The bodies of the dead washed ashore at Little Brewster Island and were buried by keeper Moses Barrett.

One grave in particular—a relatively recent one amid the plentiful dandelions behind the tower—is quite poignant. The small gravestone marks the final resting place of Farah, “a mutt and keepers’ com-



Elinor DeWire

Storm damage from the Blizzard of 1978, included this wave destruction of the old station pier. Wind prevented snow from lying

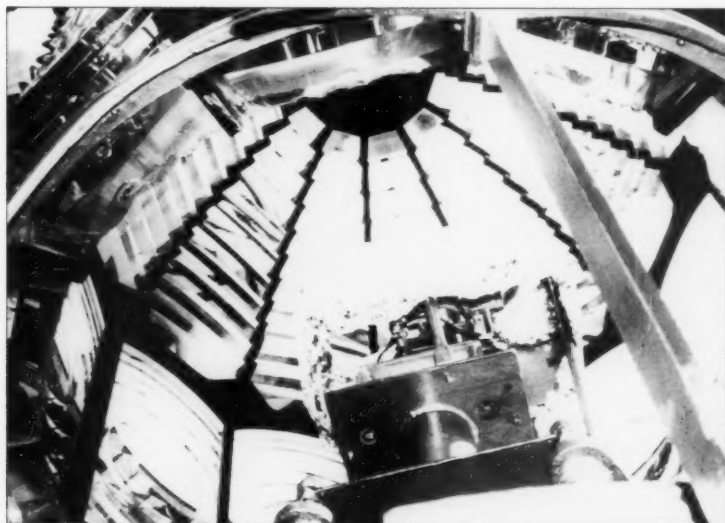
on the island, so while Boston received some 22 inches, only a dusting clung to the rocks and soil at Boston Light.

panion for many years." She died at the lighthouse in 1989.

Only twice in its long career has Boston Lighthouse stood dark. It was put out several times during the Revolutionary War, and from 1941 to 1945 it was "darkened against the night to avoid silhouet-

ting ships for enemy submarines off the coastline."

Today, an automatic bulb changer and an emergency generator ensure the light, visible 27 miles at sea, will always be shining when mariners need it.



Elinor DeWire

This is a view inside the 2d order Fresnel Lens at Boston Light. Aluminum foil pro-

TECTS the bulbs from the intense heat generated by the lanterns during the sunlight hours.



PIGEON POINT LIGHTHOUSE, SAN MATEO COUNTY, CA

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1785 Massachusetts Av., NW
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What Happens to a Ship at the Bottom of the Sea?

Peter Throckmorton
from Shipwrecks and Archaeology
Brown, Little & Co.

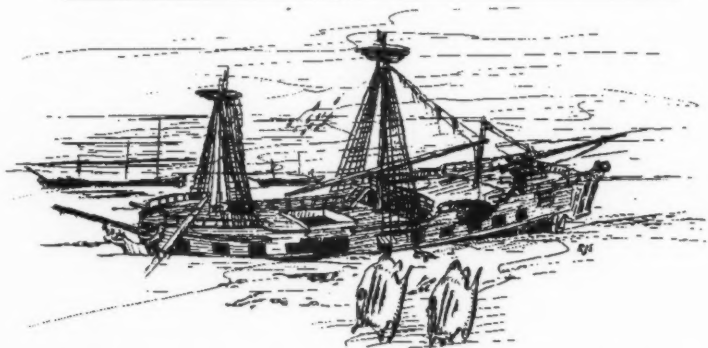
*He strack the top-mast wi' his hand,
The fore-mast wi' his knee,
And he brake that gallant ship in twain,
And sank her in the sea.*

—The Daemon Lover,
Anonymous ballad

Assuming the ship had not smashed to bits, the survival of the ship as wreck is principally dependent on the nature of the water which surrounds her. Life destroys, and here we speak of microorganisms which eat slowly and invisibly at the organic material of the ship; of the teredo worm which is said in the Far East to be edible, but certainly not enough to compensate for the terrific damage it inflicts on wooden hulls in salt seas.

Heat destroys. Richard Russell, the chemist who worked on material from a silver cargo wreck at the Great Bases, estimated that the rate of corrosion increased by something close to 100% for each degree above 0°C. Since moderate heat makes abundant life, geography and depth matter a great deal in the natural preservation of a wreck. The salt sea destroys. The index of known shipwrecks and their state of preservation varies

*This not only answers the question, but serves as a tribute to a wonderful writer, who passed away recently. His other books include *The Lost Ships* and *Spiro of the Sponge Fleet*.*



according to many factors, but, as a whole, material in fresh water is much better preserved than that in salt water...

The preservation of this ship material is a completely new problem, which is little understood. Iron cannon raised from a coral reef, can be cleaned of coral and seem in good condition, then in a few weeks fall completely apart. Iron from Roman times in the Mediterranean has almost always completely disappeared, turned to mush. Iron objects exist as negative casts, like plaster of uneven quality or blackened, solidified sand. These molds can be cut apart and cleaned out to take molding compounds, which reproduce the form of the original iron object.

A shipwreck, says Mendel Peterson of the Smithsonian Institution, resembles nothing so much as a giant galvanic battery, with the salt water acting as an electrolyte. Copper, bronze and brass are often perfectly preserved if they have not gotten involved in the electrolytic process. Gold is always incorruptible. Silver has a great infinity for sulfur, an element common in rotting shipwrecks, and usually suffers severe damage unless it is near iron, which gives cathodic protection.

Pottery lasts forever under the sea. Marble is often attacked and can be completely destroyed by seaworms. Marble from [the wrecks] *Antikythera* and *Mahdia* is like new in the side that was protected, and pockmarked beyond

recognition on the sides that were exposed to the sea.

The wood of ancient wrecks suffers a sea change as well. When uncovered it seems strong, but sometimes something has happened: the cellulose has been replaced by seawater in the course of hundreds or thousands of years. Once exposed to air, this seawater must in turn be replaced by some suitable chemical compound, or wood will shrink and disintegrate as it dries out.

The problem of what happens to undersea material promises to open a new subfield of chemistry; wood preservation is one of the major problems which confront the marine archaeologist. It is now possible to preserve small pieces of wood, but to preserve whole ships or large parts of ships is very difficult indeed. A solution both satisfactory and economical has not yet been found.

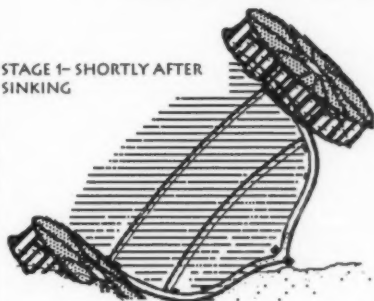
Different kinds of wood absorb and give off moisture in different ways. Oak which has lain long under the sea seems to fare worst upon drying out. Pine, elm and cedar do better.

Glass varies in chemical composition. Studies at the Corning Glass Institute indicate a possible connection between annual cycles of temperature and the formation of distinct layers in glass under sea or earth. It may soon be possible to date glass from ancient shipwrecks by this method. The sea change suffered by glass also varies according to the chemical composition of the glass.

Various interesting chemical reactions have been observed in ancient wrecks. At the *Grand Congloue*, for example, the lead sheathing which had originally covered the ship beneath the waterline was almost completely transformed into sulfate of lead. Phoenician beads

STAGES IN DEGRADATION OF A WOODEN-HULLED SHIP

STAGE 1 - SHORTLY AFTER SINKING



STAGE 2 - 50 YEARS AFTER SINKING



STAGE 3 - 100 YEARS AFTER SINKING



after Throckmorton

from *Cape Gelidonya* were soft glass which seemed strong under water and just after they were raised, but then exploded into particles of dust when left to dry out. A basket from the same wreck was preserved because it lay between two copper ingots. The chemical by-products of the slow corrosion of the copper protected the soft matting.

Like the jewels taken by Cinderella's wicked stepsisters, shipwrecks are liable to turn into meaningless junk unless the magic of modern chemistry can be applied to them.

The final question, rudely put, is of course, so what? Who

cares if a bit of planking is less rotten than one might have thought after a couple of thousand years underwater? What difference does it make to our tired planet, other than giving pleasure to a few harmless eccentrics who might otherwise be developing the pitless peach or observing wild-fowl?

The answer, equally rudely put, is, probably not much. Archaeology is, after all, only the raw material of history. And for all the good the study of history has done in terms of preventing Man's foolish-

ness, we had just as well burn the libraries down. And yet Man still craves knowledge of his own past. Few would condemn archaeology as useless. And if archaeology is justifiable, then the study of ships and their cargoes, the sea paths they sailed and the men who sailed them, is surely worthwhile.

A sailing ship, seen as an artifact, is one of the most interesting and beautiful of human creations. In it is concentrated the accumulated knowledge of half a dozen crafts through many generations. Like public buildings, ships are expressions of the societies that create them.



The *California*

Frank O. Braynard
U.S. Merchant Marine
Academy, Kings Point

*I thought it might be interesting to continue our Gold Rush theme with a great article by my good friend Frank Braynard. This is actually a story from Frank's book: **Famous American Ships**, which we have used any number of times in the past. Frank is more than generous in sharing his talent for art-work and writing and we try to take advantage of it whenever possible. In addition to numerous other accomplishments and activities, Frank acts as an advisor to the Maritime Historical Society.*

—ed.

On Friday, October 6, 1848, the 1,058-ton steamship *California* sailed from New York to open what was to become America's most famous ocean steamship line—the **Pacific Mail**. She carried only a few passengers, although she was fitted out to accommodate some 200. Her cargo consisted largely of coal, a knocked-down engine and stores for the voyage around South America. It was to be a long voyage and a momentous one. Britain had just conceded our right to the Oregon border, a right whose earliest claim was based on the voyage of the sailing ship *Columbia* a half century before. Mexico had ceded to us the great area of California in a war won with the substantial aid of ex-merchant ships pressed into service. Our

manifest destiny to rule the Continent from Atlantic to Pacific had become a reality. An alert Congress realized the need for water communications and offered a mail subsidy to stimulate the organization of a ship line to link the East Coast with Panama and Panama with the West Coast.

The *California*, little aware of the excitement that was stirring at Sutter's sawmill in the land she was named for, continued down the coast of South America. Engine trouble caused a protracted stay of three weeks at Rio de Janeiro. Rough going contributed to delay the voyage. The sturdy craft, built of live oak, maneuvered the difficult Strait of Magellan and headed north again.

A white band around her hull gave her a modern appearance. A much abbreviated clipper bow with an almost horizontal bowsprit set her apart from the sleek clippers just reaching their prime at this period. A tall single smokestack was placed forward of the paddle boxes. Square sails were rigged on fore and main with a large fore and aft sail on the mizzen. As was customary, a gigantic United States flag hung from the mizzen yard. A burgee with the name "*California*" in large letters on

white flew from the top of the mizzenmast. A long, low cabin extended from the foremast nearly to the stern, almost hidden by the high wooden bulwarks. Two lifeboats, one on either side, were hung forward of the stack, and there were two more forward of the mizzenmast.

When the *California* sighted Panama her officers were surprised to note great activity on the dock. As she approached and it became clear that she was a large ocean vessel, great crowds massed along her course. Even before she tied up, her officers were besieged with calls asking for passage to San Francisco. The discovery of gold, vast gold deposits, in California had been confirmed. Stories of gold in the area had been common on the East Coast for years. The rumors became more persistent in the fall of 1848 and by December the news was out, given added credence by an enthusiastic endorsement by President Polk.

An irony of history was this discovery of gold in California. Some 300 years earlier, Spanish gold hunters and explorers had opened the area to white men. For three centuries their descendants had lived atop one of the world's richest gold layers. It was there for

the scraping. And then, barely a year after American conquest, the discovery. A Mexican named Baptiste saw it ordered by Providence that the finding of gold be delayed until California became a part of the United States.

Crowded to the gunwales with 365 passengers, the *California* puffed up the coast for the new Mecca. The gold fever must have hummed and buzzed through every cubic inch of her 225 by 31 by 18-foot hull. Fabulous prices had been paid for her cabins, and many gladly accepted passage with no sleeping facilities. The *California's* arrival must have been a thrilling experience for all on board. She was the first ocean-going steamship to enter the Golden Gate. She was the symbol of the new sovereignty. On board was Major General Persifor Smith, the new Military Governor of the Territory. Her arrival date was February 28, 1849. It was a day to be long observed by a group of her passengers, banded together as the First Steamship Pioneers. It was a date that marked a new era of American history.

As the *California* rounded Clark's Point below Telegraph Hill the several hundred shanties and tents that were San Francisco came into view. We can imagine that most of the settlement's thousand citizens were on hand with bells on. In the harbor, riding high and

impressive midst a motley assortment of deserted sailing craft, were five ships of the United States Navy's Pacific Squadron, under Commodore Jones. They were probably the only vessels in the port whose seamen did not desert en masse for the gold fields. Sporting all officers in full dress, the flagship *Ohio* and her sisters were a fine

"Look Out For the Steamer!" A rhapsodic article followed:

"The knowing ones say that we may daily look for the first steamer. If this be so, ought not our citizens to take some steps to manifest their joy at an occasion so full of interest to this port? We most strenuously recommend the holding of a public meeting, the appointment of a committee of arrangements,

and the raising of a fund for burning of powder and spermaceti on the occasion.

It is an event so fraught with future hopes of advantage, that our memories will almost deserve execration if we do not celebrate... with proper style and spirit. It is an epoch...

Come, come, you that have amassed so much gold since the opening of the mines... and let us show the newcomers that this is a land

of cakes,

jollity, generosity, and kind-feelings, as well as a land of enterprise and gold."

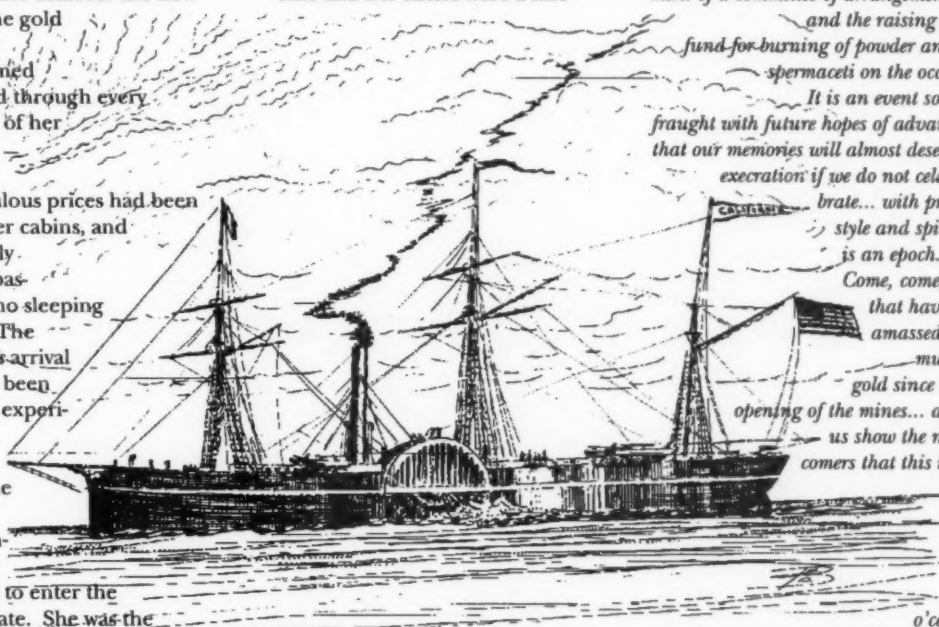
When the Pacific Mail liner actually did arrive, the newspaper's enthusiasm mounted to new heights. The passage reporting the event is quoted in Kemble's *The Panama Route, 1848-1869* as follows:

"The *California* is a truly magnificent vessel, and her fine appearance as she came in sight off the Town, called forth cheer upon cheer from our enraptured citizens, who were assembled in masses upon the heights commanding a view of the Bay, and in dense crowds at the principle [that how the editor spelled it] wharves and landing places."

Within a decade the trade

sight. As the *California* approached, the squadron's entire complement, 1,500 men, manned the yards in salute. Roaring broadsides from each vessel gave noisy welcome. The *California's* anchor chain rattled and splashed into the blue harbor depths. With bated breath her passengers swarmed ashore. Her crew did too, for to a man they deserted, with the exception of Captain Cleveland Forbes and Third Assistant Engineer Fred Foggin.

The local newspaper (one had already been set up) went into raptures at the approach of the *California*. Interest was at a high pitch as the banner headline ran



between New York and San Francisco was supporting 29 steamships. They brought 175,000 passengers to the Golden Bear state, returning some \$2,000,000,000 in gold. The railroad was still years away.

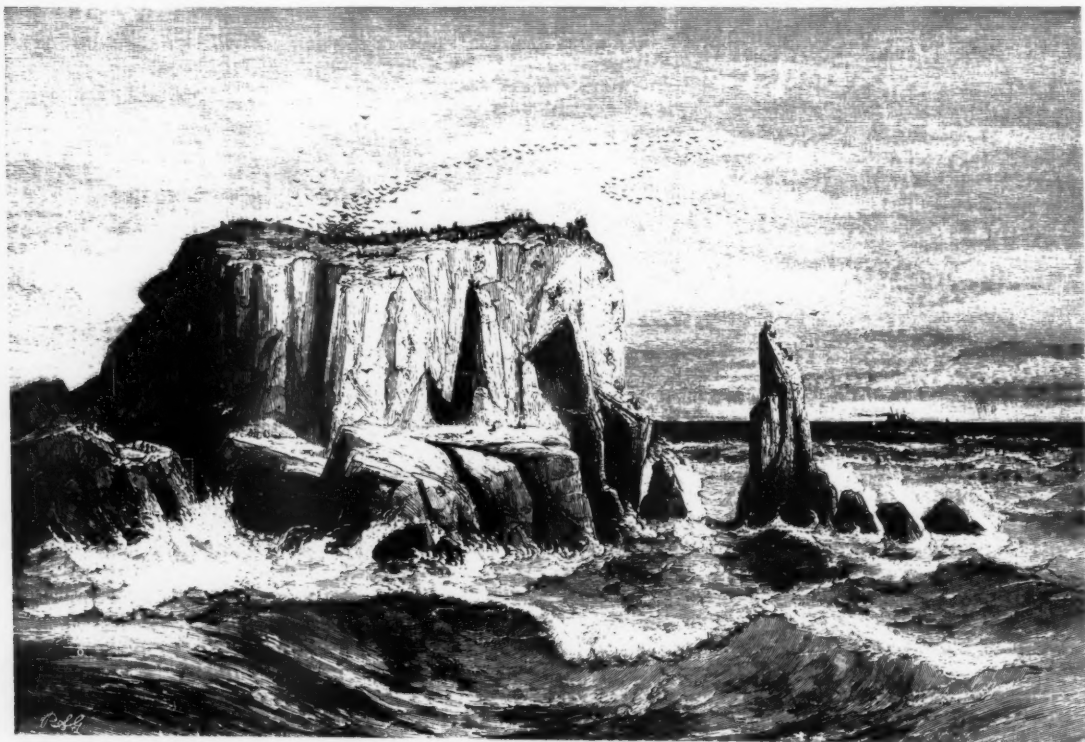
Among these early passengers were the famous "Mercer girls." Brought from the East by Asa B. Mercer, they were destined for Seattle, to meet the dearth of eligible young ladies as brides of the bachelor settlers. The first lot of eleven reached Seattle safely, but money problems stranded the second contingent of forty-six in San Francisco. There, according to Henry G. Alsberg's *American Guide*, local swains snatched away a goodly number. With the survivors Asa

proceeded to his destination. Eventually he became President, and for a time the entire faculty of the Territorial University in Seattle (today's University of Washington). One of the "Mercer girls," we might add, became Mrs. Asa S. Mercer.

New gold discoveries in Australia and Alaska retained for the area a certain primitive flavor long lost in the East. Ships, both offshore and river, remained the handmaidens of progress and prosperity. The first steamship to cross the Pacific, it might be noted, was the *Monumental City*. The lure of gold had brought her. Built at Baltimore in 1852, she was wrecked on her first voyage in Australian waters a year later.

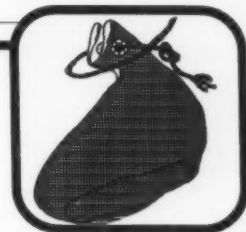
The *California* was to live

on and on to the remarkable age of 46 years. Hers was not an uneventful career. On one occasion she ran out of coal and had to burn her own spars. On another occasion an engine breakdown forced her to continue under sails alone. Another time she rescued the women and children and part of the mail from the newer and larger steamer *Winfield Scott*, which had gone ashore. As new ships came out she was assigned to less important services. Passing into different hands, the *California* was finally converted into a sailing craft in 1875. As a lumber bark she was long familiar up and down the coast under a foreign flag. She ran aground and was lost in January, 1895, off Peru.



R. Swain Gifford

Coast Scene, Marin County



AMVER & VOS

Capt. James Drahos

Master, *Sea Wolf*

“When I read “AMVER Clarification” in the *Mariners Weather Log* (Winter, 1990, pg. 34), I was very surprised. It had always been my understanding that the AMVER plot was updated by OBS positions. Further, more than disappointment, it bothered me that a valuable asset was being wasted, ignored, disregarded—surely, I thought, an actual position at intervals of 3 or 6 hours was more valuable (and accurate!) than a mere 48 hour update. This is more than a matter of duplicated messages and needless expense—it is a matter of increased safety at sea for little or no additional expenditure of effort or money.

After discussing the subject with Jim Farrington, the SEAS coordinator at Norfolk, I decided to write the Coast Guard/AMVER. Two letters were required—it turns out the address in the *AMVER Bulletin* is not the one to write to! In due course the CG replied—after a telephone call to reassure me that a reply was on the way and to explain why there had been such a lengthy delay (8 months) after the initial letter. I am happy to note a positive clarification to the AMVER Clarification was provided by the Coast Guard.

As the CG noted in their reply of 20 Mar 91, the AMVER Clarification was both right and wrong. The AMVER and VOS systems do not directly communicate with each other. However, AMVER receives a twice-daily listing from the Navy's Fleet Numerical Oceanographic Center (FNOC). This listing is derived from the VOS OBS data and “...contains the call sign, position, course indicator, speed indicator, day and hour portions of synoptic weather messages from ships at sea.” This information does update the AMVER plot.

A further clarification (to the *Clarification!*) is that the VOS updates (via FNOC) will meet AMVER

and MARAD reporting requirements when a Sail Plan/Departure Report and Arrival Report are filed.

The letter goes on to state that FNOC updates are sometimes meaningless to the plot when a Sail Plan/Departure Report has not been received beforehand. It seems safe to infer that a MARISAT-transmitted Sail Plan/Departure Report, direct to AMVER Center, NY, will be timely enough.

I hope this will be the final “clarification”! Mariners can rest assured that their synoptic OBS (3 or 6 hour) will update their AMVER plot and comply with MARAD requirements, provided the appropriate Sail Plan/Departure Report has been filed. Safety and efficiency are, thus, well served. Many thanks to the CG for clearing this up, albeit serendipitously!”

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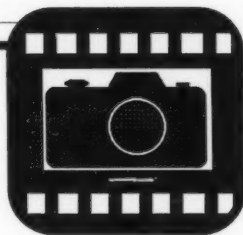
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Stability at Sea

Michael Halminski

Being on the water affords many opportunities to photograph in rough seas, which nearly always presents some problems in picture clarity and sharpness, simply because of the relatively continuous motion. The best way to correct this is to use fast shutter speeds. Typically, I use moderately slow films rated at 50 or 64. As films become more sensitive to light, they are referred to as being faster. Some common films are rated at 100, 200, 400 and even up to 1200 or higher. This is an International Organization for Standardization (ISO) rated speed. If you look at a sequence of available film speeds in a particular brand, you will notice that every third number is doubled (approximately). This represents an increase of one stop, which would be the equivalent of a change in aperture from f8 to f5.6 or a change in shutter speed from 1/125th to 1/60th of a second. Under normal daylight conditions the slower films serve me well with shutter speeds in the 1/125 to 1/500th second range. When I am confronted with stopping motion, as in a moving boat, I strive for at least 1/500th of a second, or 1/1000th of a second if I can get that.

Under low light conditions this is not always possible, and with my preferred slower films, I may have to push my limits of shutter speeds down to 1/250, 1/125, or even 1/60th of a second. This is when getting crisp images can be a gamble, and the problem is intensified with heavier seas or lenses of stronger magnification. The greater the focal length, the faster the shutter speed needed to attain sharpness. Lenses of lesser focal length tend to alleviate this problem.

An alternative in this case to achieve faster shutter speeds, is to use a faster film with a by-product of increased grain effect. As a personal preference this may or may not be a bad thing. Another approach is to use a faster lens; for example, a maximum aperture of 1.2 is better to use than a lens with an aperture of 2 or 2.8. The highest shutter speed capability is employed when the lens is wide open. This does reduce the depth of field, or the range of what's in focus. The main disadvantage is that the faster lenses are significantly more expensive, so the pros and cons need to be thought out before buying.

One technique that I often use is to snap my picture as the vessel is at the peak of its rise, where it seems to stop for a moment, before going back down into a wave. That way, in theory, I can click the camera when things are comparatively still.

The accompanying photographs, I shot of *Bailey Boy* to illustrate a story on fishing trawlers out of Wanchese, NC. Skies were overcast, and all I had was my old standard Kodachrome 64, that I rate at 80. In a situation of this nature, I'll often make a number of exposures and hope that at least something turns out with clarity and detail.

One shot was taken at 1/250th of a second and shows a blur of camera movement in relation to the subject, while the other shot is very sharp, thanks to a shutter speed of 1/500th of a second and a bit of luck.

Remember, if a particular question or problem about photography at sea comes to mind, don't hesitate to write to me:

Michael Halminski
Photographer
Waves, NC 27982



The photograph of the Bailey Boy (above) was shot with a 55 mm lens at an opening of f5.6 at 1/250th of a second. Compare this with the photograph below, which was taken at f3.5 with an increase in the

shutter speed to 1/500th of a second. There is an improvement in clarity. This comes sometimes at the expense of the depth of field, which in this case was not as important as clarity of the vessel.



Sea Photography

The following photograph and note was submitted by Able Seaman Dave Cook of Maumee, Ohio:

"Had I known you folks accepted readers' photos, I would have sent this one along sooner. It was not until fit-out this spring, while I was reading the *Mariners Weather Log*, that I realized I could send this picture in.

This photo was taken on the morning of November 30, 1990, aboard the *S.S. Sparrows Point*, a self-unloader type bulk carrier owned and operated by the Bethlehem Steel Corporation under the command of Captain Pat Nelson. We had transited the straits of Mackinaw, westbound, when we came out of the lee of Gull Island and encountered 32-knot southwesterly winds. We calculated

the seas to be 14 to 16 feet with occasional rogue waves well in excess of 20 feet. The ship was loaded and we had 14 feet of freeboard. I was standing on the foc'sl deck, behind the forward house, facing aft when this particular wave came aboard. As it passed by my right, I had to look up at the crest. It first broke over the rail at number 3 hatch and rolled right on down the spar deck, well past mid-ship. Our decks were awash and we continued to take seas aboard throughout the morning and early afternoon, until we got into calmer waters off the eastern coast of Wisconsin. I certainly hope you folks enjoy this photo as much as we have here on the Lakes. I have made over 100 reprints of it due to popular demand by lake sailors."

These are the types of photographs we love to get. Any type of weather phenomena or oceanographic shot is always welcome. In fact, we always like a good photograph of any of the ships in the VOS program as well. We can convert color into black and white very easily, and if you need the photo to be returned we will do that too. While we can't guarantee we will publish all of them, we will try to do our best. If we see a particularly outstanding one, we will be glad, with the photographer's permission, to submit it to *Weatherwise* magazine for their annual weather photography contest. Send to:

Mariners Weather Log, NODC
1825 Connecticut Av, NW
Washington, DC 20235





Ship Awards and Other News

Martin S. Baron
National Weather Service
Silver Spring, Md.

Obituary

With great sadness, I must report the sudden death of Royce Hildebrand, PMO in New Orleans, on June 18, 1991. Royce had just been appointed in February of 1991, and was well on his way to becoming an outstanding PMO. We join the Hildebrand family in their grief. The family asks that donations on Royce's behalf be sent to the American Heart Association. Correspondence can be sent to Mrs. Royce Hildebrand, C/O Mr. Fletcher Sellers, 5321 Catherine Drive, Satsuma, Alabama 36572.

Eastern/Southern Region PMO's Unable to Travel

Due to a very severe budget shortfall facing the NWS, PMO's in the NWS Eastern Region (Cleveland, New York, Newark, Baltimore, Norfolk), and NWS Southern Region (Jacksonville, Miami, New Orleans, Houston) are currently restricted in performing their regular ship visitations. Restrictions have also been placed on other

(non-marine) NWS programs and activities. These constraints should be lifted at the start of the next fiscal year (October 1).

PMO's in the other NWS regions (Los Angeles, San Francisco, Seattle, Anchorage, Valdez, Kodiak, Honolulu, Chicago) have not been affected thus far, and are performing their ship visitations as usual.

New Supplies Available

We have re-printed several items, some with improved design, for use by Voluntary Observing Ships. Form B-81, Ship's Weather Observations, has been reduced in size (folded) for easier handling. Updated versions of the cloud and sea-state posters, and Marine Weather, by Nathaniel Bowditch, are now available. A brand new edition of NWS Observing Handbook No. 1, Marine Surface Weather Observations, has been completed and is at the printer. We expect to have it stocked by mid-late August. Please contact

your PMO to obtain these and other program forms and supplies.

VOS Ship Awards For 1990

We are pleased to report that 44 Voluntary Observing Ships (VOS) will receive Outstanding Performance Awards for their contributions as weather observers during 1990. The entire Marine Observations Program staff congratulates these vessels for their exceptional level of support. There are over 1600 vessels in the National Weather Service (NWS) VOS program, all of which make important contributions. Awards are reserved for those few vessels providing a rare level of unusual and superior support.

New Recruits April - June, 1991

PMO's recruited 43 vessels into the VOS program during April, May, and June of 1991. The list of new participants is on page 42. Thank you for joining the program.

Marine Observation Program

NATIONAL WEATHER SERVICE VOLUNTARY OBSERVING SHIP PROGRAM NEW RECRUITS FROM 01-APR-91 TO 30-JUN-91

NAME OF SHIP	CALL	AGENT NAME	RECRUITING PMO
ACONCAGUA	CBAC	STRACHAN SHIPPING CO.OF TEXAS	HOUSTON, TX
ADVANTAGE	WPPO	RED RIVER CARRIERS	NORFOLK, VA
ALWATTYAH	A6LN	UNITED ARAB SHIPPING COMPANY	NEWARK, NJ
ALABAMA RAINBOW	3EJQ7	TOKAISHIPPINGCO.LTD (T.B.R.BUILDING)	LOSANGELES, CA
ALLIGATOR COLUMBUS	3ETV8	WILLIAMS, DIAMOND AND CO.	LOSANGELES, CA
AMOCO CAIRO	A8JP	AMOCO TRANSPORT COMPANY	HOUSTON, TX
ASTRO COACH	ELJY2	NYK CAR CARRIERS OPS GP4	JACKSONVILLE, FL
BAKRI VOYAGER	LAGV2	MAX MARINE COMPANY	HOUSTON, TX
C.W.KITTO	A8FX	CHEVRON SHIPPING CO.	HOUSTON, TX
CHO YANG SUCCESS	D9SI	CHOYANG (USA)	SANFRANCISCO, CA
CO-OP EXPRESS III	ELJW5	MTSUI OSK LINES, LTD.	JACKSONVILLE, FL
CONTIENTAL WING	ELJS6	ACT MARITIME CO. LTD.	LOSANGELES, CA
CREST UNITY	3EMS8	KERR STEAMSHIP CO	SEATTLE,WA
ECSTASY	ELNC5	CARNIVAL CRUISE LINES	MIAMI, FL
ELSAM FYN	OVQV	THE EAST ASIATIC COMPANY LTD. A/S	NORFOLK, VA
EVER GOODS	BKHZ	EVERGREEN INT'L (USA) CORP	NEWARK,NJ
EXXON BAYTOW	NKFFPM	EXXON SHIPPING CO	SANFRANCISCO, CA
GEORGIA RAINBOW II	3ERJ8	TOKAI SHIPPING CO	JACKSONVILLE, FL
GLOBAL LINK	WWDY	JOHN S. CONNER	BALTIMORE,MD
GOLDEN TOPAZ	DUWR	DAIDO KAIUN KAISHA LTD	SEATTLE, WA
GREEN ANGELES	3ENQ5	INTERNATIONAL SHIPPING CO INC	SEATTLE, WA
HANJIN FELIXSTOWE	D9TJ	HANJIN SHIPPING COMPANY	LOS ANGELES, CA
HANJIN HAMBURG	D9TP	HANJIN SHIPPING COMPANY	LOS ANGELES, CA
HANJIN OAKLAND	D9SG	HANJIN SHIPPING CO.	LOS ANGELES CA
HANJIN SINGAPORE	D9IX	HANJIN SHIPPING CO.	LOS ANGELES, CA
JOANN M	C6HV3	SOUTHERN STEAMSHIP	JACKSONVILLE, FL
KEBAN	TCCV	NAVIOS SHIP AGENCIES	HOUSTON, TX
M.V. OSPREY	WQZ3314	CHESAPEAKE BAY FOUNDATION	BALTIMORE, MD
MAMAIA	YQSD	ROMANIAN SHIPPING COMPANY	HOUSTON, TX
MERIAM HOPE	9HHH3	GOLD MARITIME LIMITED C/O UNIFIDA	NEWARK,NJ
MING PEACE	BLIG	SOLAR INTERNATIONAL SHIPPING	LOS ANGELES, CA
NIPPON HIGHWAY	3ENR6	NIPPON KISEN CO. LTD.	LOSANGELES, CA
OCEAN VICTOR	ELHN6	AMOCO TRANSPORT COMPANY	HOUSTON, TX
OCEANUS	WXAQ	WOODS HOLE OCEANIC INSTITUTION	NEW YORK CITY, NY
OMI CHARGER	KMLK	MORAN GULF SHIPPING	HOUSTON, TX
RIO NEGRO II	LRQU	STRACHAN SHIPPING COMPANY	HOUSTON, TX
RUBIN DOGA	3ELW4	INTERNATIONAL SHIPPING CO INC	SEATTLE, WA
SITHEA	LADO4	SITE INTERNATIONAL A/S	SEATTLE, WA
SPIRIT	WAP5969	NATIONAL WEATHER SERVICE	LOS ANGELES, CA
STAR STRONEN	LAHG2	GULF OCEAN SHIPPING CORP.	HOUSTON, TX
TELINA	DULM	CASCADE SHIPPING CO	SEATTLE, WA
TEXAS CLIPPER	KVWA	TEXAS MARITIME COLLEGE	HOUSTON, TX
USCGC MOHAWK WMEC 913	NRUF	COMMANDING OFFICER	JACKSONVILLE, FL

Outstanding Performance Awards for 1990

Ship Name	Call Sign	Ship Name	Call Sign
Atlantic Ocean	ELIG8	Puritan	DHOU
Bridge Bay	ELES7	M/V President Eisenhower	KRJG
Caribe 1	3EIC2	President Lincoln	KDBG
M/V Century Highway No. 5	8JPX	President Washington	WHRN
Chablis	WEMS	Rover	KRBS
M/V Charles E. Wilson	WZE4539	M/V Sea Wolf	KNFG
Chesapeake Trader	WGZW	Sea-Land Enterprise	KRGB
Edwin H. Gott	WQZ29670	M/V Sea-Land Navigator	WPGK
Emerald Sea	LAHA2	M/V Sea-Land Pacific	WSRL
M/V Ferncroft	LLEJ3	Sea-Land Voyager	KHRK
Great Land	WFDP	Sea Merchant	DHCU
M/V Green Bay	KGTH	Sea Trade	DALU
Lee A. Tregurtha	WUR8857	Texas City Sea	5LQT
Moku Pahu	WBWK	Trader	KIRH
R/V New Horizon	WKWB	Triton	WTU2310
NOAA Ship Discoverer	WTEA	Tumilco	KCIT
NOAA Ship Ferrel	WTEZ	USCGC Citrus	NRPQ
NOAA Ship Malcolm Baldrige	WTER	USCGC Chilula (WMEC 153)	NPIN
Orange Blossom	ELEI6	USCGC Northland (WMEC 904)	NLGF
Overseas Harriet	WRFJ	USCGC Steadfast (WMEC 623)	NSTF
M/V Polynesia	D5NZ	USNS Sealift Atlantic	NIKA
PFC William B. Baugh	KRPW	Westward Venture	KHJB





"I have the feeling we're not in Kansas anymore."

—Dorothy in the Wizard of Oz

The following was submitted by Bob Novak, PMO Oakland: On April 6, 1991 the *President Johnson* experienced a severe local storm while anchored off Kao Hsiung, Republic of China (Taiwan). The event took place from 0535 to 0545 UTC. I interviewed the Captain, 1st Mate and the officer who was on duty during the event. They all mentioned that there was lightning just moments before being hit. The storm seemed to have formed near or over the ship and moved only a short distance, if at all before all hell broke loose. There was no mention of any funnel clouds or waterspout, before, during or after the event. The feeling was that it all happened right over the ship. The 1st mate stated that he thought the ship was picked up and moved.

The following is the report from the Master and crew of the *President Johnson*:

"At 1158 (LST) on April 6th the *President Johnson* anchored up short; (5 shots in approximately 80 feet of water), to await the Kao Hsiung pilot who was due to board at approximately 1500 hours. Steam was maintained on the engine due to the expected short duration of the vessel's anchor period.

At approximately 1335 hours we started to experience

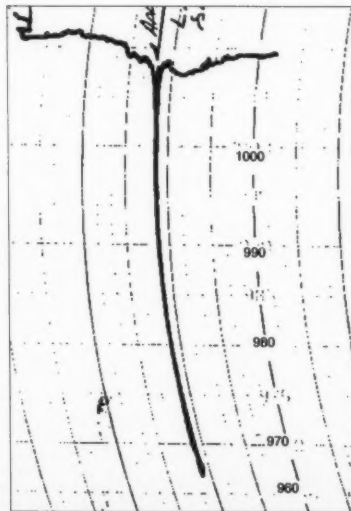
heavy rains and winds of 30 to 40 knots, normally associated with the passage of a local storm front, not uncommon for this time of year. As we were anchored up short, the master was on the bridge during the passage of this front to monitor the ship's position.

At approximately 1340, the wind reached 80 to more than 90 knots, visibility was reduced to zero and the ship lay over 10° plus. About this time the atmospheric pressure dropped 40 millibars in less than 5 minutes. Various crew members have described the sound as that of a passing freight train: one crew member thought we had struck another ship and were scraping down its side. Members of the crew also noted that their ears popped, the windows bowed in then out and the bulkheads likewise bowed and emitted popping noises. Water squirted in horizontally through exterior door seals. The *Johnson* drug anchor approximately 0.5 miles in less than 5 minutes. Half astern was rung up on the engines to prevent a collision with a loaded tanker at anchor. The Closest Point of Approach (CPA) to the tanker was determined by radar to have been 500 yards. Visibility was 10 feet. As the wind subsided to 30 to 40 knots, the anchor was raised and the *Johnson* proceeded out of anchorage.

During the height of the storm three empty containers, in the middle of row 17, were ripped out of their lashings. One contain-

er traveled straight up about 50 feet and struck the range light mast causing severe damage, then came down and struck the starboard lifeboat as it went over the side. Two containers lodged themselves between row 17 and the house. Metal fragments struck the MARISAT antenna and put a 1 foot square hole in the dome. The ship's main transmitter antenna was sheared off at the base and landed on the sundeck. Catwalks between the hatches were ripped out. The starboard lifeboat was a total loss.

Miraculously only one crew member was injured. Dale Cunningham, our electrician, was adding water to the batteries in the diesel generator set at row 20 when the storm struck. The sharp drop in atmospheric pressure caused the



pneumatic controls on the diesel generator's CO₂ system to release, flooding the diesel generator container with CO₂ while the electrician was inside. Mr. Cunningham exited the container by feeling his way out and made his way down to the main deck. While trying to find shelter on the main deck, he was picked up by the wind and blown down the deck. He finally was able to grab a vent and shield himself

from the wind. As the wind subsided, he crawled to the main deck door and was hauled inside by two A.B.s. He was bruised but had no major injuries.

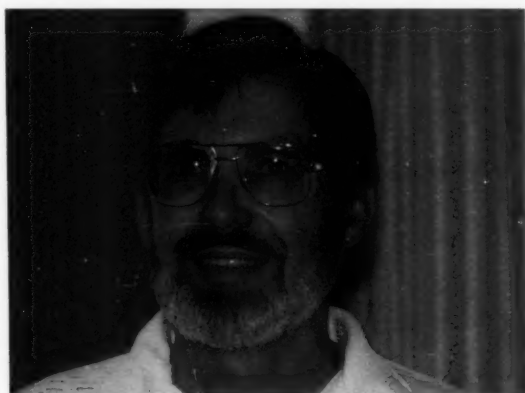
The total time the *Johnson* spent in this storm was approximately 5 minutes. Damage was estimated to be in excess of \$75,000. No other vessels in the anchorage encountered this storm or sustained any damage. Four fishing

vessels were reported capsized or sunk, however.

We are grateful to the crew and Master of the President Johnson for this fine report and are thankful that no one was seriously hurt. From all appearances they were in a tornadic waterspout. All available data are now being collected and analyzed by waterspout expert Joe Golden of NOAA and hopefully we will be able to carry the results of his research in a future issue.

—ed.

Getting to Know Your PMO



Dave Bakeman, PMO Seattle

MWL: Dave, how long have you been the PMO for Seattle?

Dave: Oh, it's been about 5 years now. My seagoing time is limited, although I have been through five hurricanes, two of them at sea.

MWL: I can see why you want to stay on land. What did you do before, within NWS?

Dave: I was a real wanderer. Since 1956, I saw action in about 14 locations including the wilds of Alaska, Salt Lake City, Marcus Island, Tatoosh Island—all the hot spots.

MWL: Where are the major Seattle port facilities?

Dave: The two major facilities are at Puget Sound and Tacoma.

MWL: What do the ports handle, mostly?

Dave: Containers.

MWL: What do you enjoy most about being a PMO?

Dave: You get to meet many people and there is a lot of traveling, which keeps you out of the office more than half the time.

MWL: Is Seattle traffic mainly overseas?

Dave: Yes, nearly all of it is to and from foreign ports, such as Tokyo, Taipei and the like.

MWL: What types of vessels do you serve?

Dave: There are quite a variety, including Coast Guard, NOAA, ferries, liners, oilers, car carriers and bulk carriers.

MWL: Does the Seattle area involve a lot of travel?

Dave: About 350 miles of waterfront.

MWL: Are there seasonal variations in shipping?

Dave: Very few

MWL: Tell us a little about your family.

Dave: John is a seaman, and David is into computer research and development. Jeff and James are in the building trade, Davey is in manufacturing, while Lorraine welcomes pen pals worldwide.

MWL: Any hobbies, besides the above?

Dave: Mustang cars, photography and travel.



Awards for 1990 Begin

The VOS Awards for outstanding observations during the past year are now being given by the PMOs to the deserving ships. It is our privilege to carry these presentations whenever possible. Above, is an old familiar face (stress the old) Jim Nelson presenting to the Master of the M/V Bibi, Captain Baker, a Canadian VOS best observing ship award for 1989. The award is a seal for their certificate and the book "Canada and its People." Jim presented the award for Vancouver PMO, Bob



McArter, who could never seem to catch the ship. It was Jim's pleasure to do this for the Canadian government, and as we all know, there are no lengths to which Nelson will not go to be in a photograph. An award (below) is displayed by C/O C.J.L. Miller, on the left, along with Captain B.M. Simpson representing the M/V Polynesia. This is the third year in a row that the vessel has come away with the honors in PMO Bob Webster's region. Below, left is the presentation of an award to the **President Eisenhower**. Pictured (from left to right) are Captain. W. F. Mullen, 2/O G. Mulholland and from NOS, SEAS, Steve Cook.



Pilot Chart News

PMO Ray Brown recently reported that the DMA Pilot Charts will no longer be distributed on a quarterly basis. They will be put in an atlas type format and distributed at 5-year intervals according to a source at DMA. The last set in the regular quarterly distribution will be January, February and March 1992.

The history of the Pilot Charts can be traced all the way back to Benjamin Franklin and, of course, Matthew Fontaine Maury. The National Oceanographic Data Center and the National Climatic Data Center have provided the climatology for the Pilot Charts over the years.

More Awards

Below, Captain M. Michaelson of the *Sealand Enterprise* received the ship's second award for its outstanding effort in recording both surface and bathy (XBTs) observations. To the right the *Greatland* is receiving an award she earned in 1989. Presenting the award is Bob Decker (left), SEAS representative in Seattle, WA. The recipients are Chief Mate George Emmons (center) and Captain William Roffey.



The *Edwin Gott* was an award winner on the Great Lakes in 1990 as her crew took just under 1,000 observations during the season. To the right and pictured from left to right are: Captain Albert D. Nelson, 1st Mate Cosmo J. Arcaro, 2d Mate Richard D. Robertson and in the back is 3d Mate Bruce E. Doyle. The combined experience of the four man team is 115 years, so they really do understand the importance of good weather information on the Great Lakes. Captain Nelson skippered the *Arthur M. Anderson* when she won her award a few years ago.



Collins Report

Bob Collins, PMO Chicago has been keeping busy this fall and winter. He has made several marine weather presentations to various groups including the Corinthian Yacht Club, the U.S. Life Saving Association, the Fox Valley Power Squadron and the U.S. Power Boat Squadron in Waukegan. These seminars deal with topics such as water-spouts, lightning, tornadoes and some NWS programs. He has been averaging about 12 seminars per month.





Tossing this trash overboard could leave death in your wake.

Throwing a few plastic items off a boat may seem harmless enough. What's one more six-pack ring, plastic bag, or tangled fishing line?

Actually, it's one more way a fish, bird, seal, or other animal could die.

Fish, birds, and seals are known to strangle in carelessly discarded six-pack rings. Sea turtles eat plastic bags – which they mistake for jellyfish – and suffer internal injury, intestinal blockage, or death by starvation.

Other plastic trash can be dangerous, too. Birds are known to ingest everything from small plastic pieces to plastic cigarette lighters

and bottle caps.

Birds, seals, sea turtles, and whales die when they become trapped in old fishing line, rope, and nets.

Plastic debris also can foul boat propellers and block cooling intakes, causing annoying – sometimes dangerous – delays and causing costly repairs.

So please, save your trash for proper disposal on land.

That's not all you'll be saving.

To learn more about how you can help, write: Center for Marine Conservation, 1725 DeSales Street, N.W., Suite 500, Washington, D.C. 20036.

A public service message from:
The Center for Marine Conservation
The National Oceanic and Atmospheric Administration
The Society of the Plastics Industry



Central America Hurricane of 1857

Charles E. Herdendorf and Judy Conrad
Columbus-America Discovery Group

(In Ivan Tannehill's classic *Hurricanes* he states: "During the next ten years, 1857 to 1866, there appears to have been a remarkable scarcity of violent hurricanes." *Atlantic Hurricanes* by Dunn and Miller makes no mention of the hurricane of 1857 in their table of Tropical Cyclones in the South Atlantic States. Only Ludlum's *Early American Hurricanes* and NOAA's *North Carolina Hurricanes* made mention of the September storm of 1857. The research done by the Columbus-America Discovery Group has added a significant summary to the history of notable U.S. hurricanes. This material is copyrighted by the Columbus-America Discovery Group, Inc. —ed)

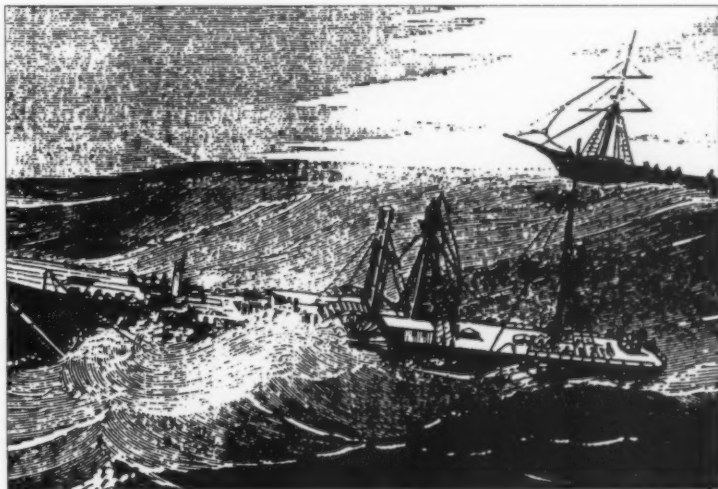
It was on September 9, 1857, off Florida, that the S.S. *Central America* first began to feel the effects of the hurricane. They continued northward and conditions deteriorated. They were not alone however. As shown in the table that follows, several other ships were lost and over 40 others damaged.

The storm was also being felt along the coast. At Wilmington and New Bern the surge rose above the wharves and into the streets.

One account notes that, "even though merchants moved their goods to upper storerooms, the height of the tide was such that barrels of turpentine and other goods drifted into the streets." At Charleston, South Carolina, on September 11th the weather was described as, "stormy with winds mounting to force 5 from the northeast." The barometer sank to its lowest point, 29.88 inches, on the afternoon of the 12th. At Georgetown it reached an even

lower point, 29.61 inches at 1530 on the 12th. By then the winds had backed to the northwest and finally to the west at 2100. Heavy rains were reported through the entire period of the storm.

In his *Early American Hurricanes: 1492-1870*, David Ludlum reports that the sinking of the *Central America* is the greatest single ship disaster of a commercial vessel attributable to a hurricane. Of the other vessels caught in the storm, one near Frying Pan Shoal appar-





Harper's Weekly

Wreck of the Central America — Adrift on the Ocean

ently passed through the center of the disturbance early on September 12th. Ludlum relates that this ship had been taking gales from the east northeast, after they blew from the east southeast on the previous day. From 0200 to 0900 on the 12th, the vessel "wallowed" in heavy seas with the "wind down," most likely in the eye of a slow moving hurricane. After 0900, the full fury of the storm struck the vessel again, this time from the west to north. By afternoon the wind had swung to the south and after midnight it had slackened to a mere breeze as the storm moved away.

Another harrowing experience was reported by the 785-ton side-wheel steamship *Southerner* out of New York bound for Georgia.

She encountered a severe blow about 20 miles south of Cape Look-out. Southeast winds "blew a perfect hurricane" on the evening of September 11th, but shifted around to the northwest by 0800 on the 12th and continued at gale strength until the morning of the 13th. She lost her wheelhouses, smoke stack and two boats in the storm as well as sprung a leak. Part of her cargo was thrown overboard to lighten her load. A religious service was held later in the day (Sunday) as a thanksgiving for deliverance from the ravages of the storm. By afternoon the gale had moderated, but the ship still labored very hard, and the water increased in the hold. All hands and passengers continued working the pumps and buckets

until the night of the 14th when the machinery was in working order.

That afternoon, about 35 miles east-northeast of Frying Pan Shoal, the brig *Elizabeth Watts*, 19 days out of Jamaica bound for New York, came alongside and supplied the *Southerner* with provisions and lay by until she got underway. Originally bound for Savannah, the *Southerner* put in at Charleston for repairs. Later in the week at Charleston, the passengers assembled at a local hotel "to pay testimony and praise to the ship's captain [Capt. Robertson] whose handling of his vessel during the gales was thought to have saved her from the *Central America's* fate."

Hurricane Alley

VESSELS KNOWN TO HAVE EXPERIENCED THE S.S. CENTRAL AMERICA HURRICANE OF SEPTEMBER 1857

VESSEL NAME	TYPE	MASTER	ROUTE	REMARKS
<i>A Blanchard</i>	brig			
<i>Abdel Kader</i>	schooner		Wilmington, NC to New York	grounded east of New Inlet bar; total loss
<i>Alabama</i>	steamship		New York to Savannah	towed schooner <i>Ida</i> to Savannah
<i>Albert Cooper</i>	brig		Portland to Cardenas	
<i>Albion</i>	schooner		Calais to Philadelphia	
<i>Amanda Powers</i>	schooner			
<i>Amelia</i>	bark		Havana to New York	lost fore, top, main, mizzen sails, flying jibboom
<i>Atlanta</i>	steamship	Capt. Gager	Charleston to New York	experienced heavy gales
<i>C. F. A. Cole</i>	schooner		New Bedford to Baltimore	lost anchors; put into Norfolk
<i>C. P. Williams</i>	schooner		Jersey City to York River, VA	lost mainmast, foretopmast
<i>Central America</i>	steamship	Capt. Herndon	Havana to New York	foundered about 160 miles off Charleston; 425 lives, gold lost
<i>Charles A. Griffin</i>	schooner		Baracoa, Cuba to New York	lost deck load
<i>Charles B. Truitt</i>	bark			
<i>Charles McClue</i>	schooner		At anchor Beaufort, NC	fouled by schooner <i>R. C. Standard</i> ; both went ashore
<i>Colin McRae</i>	bark		Liverpool to Wilmington, NC	aground at Wilmington; total loss
<i>Columbia</i>	steamship	Capt. Barry	New York to Charleston	lost paddle boxes and part of deck
<i>Commerce</i>	schooner	Capt. Vaughan	Savannah to Baltimore	
<i>Crawford</i>	schooner		At anchor in Chesapeake Bay	lost boats, anchor; sprung leak
<i>Cuba</i>	bark			
<i>E.C. Felter</i>	schooner		Charleston to New York	stove bulwarks, lost jibboom; sails split
<i>El Dorado</i>	schooner	Capt. Stone	Galveston to New York	attempted to assist <i>Central America</i> ; foregaff carried away; foresail split, bulwarks stove
<i>Eldon</i>	bark			
<i>Elizabeth Watts</i>	brig		Jamaica to New York	provided assistance to stricken steamer <i>Southerner</i>
<i>Ellen (Norwegian)</i>	bark	Capt. Johnson	Belize, Honduras to Falmouth	foremast broken; shrouds lost; made water; rescued survivors of <i>Central America</i>
<i>Emily Ward</i>	schooner	Capt. Bradley	Charleston to New York	foundered near New Inlet bar; lost
<i>Empire City</i>	steamship	Capt. McGowan	Havana to New York	lost wheelhouse, fore spencer, main gaff, other sails; put into Norfolk
<i>Eureka</i>	schooner	pilot boat	Quincy harbor	
<i>Falcon</i>	steamship	Capt. Brown	Savannah to New York	
<i>Ida</i>	schooner		Wilmington, NC to New York	towed to Savannah by steamship <i>Alabama</i>
<i>J. J. Cobb</i>	bark	Capt. Peterson	Havana to New York	lost main spencer, head sails; cabin filled with water
<i>J. W. Blodgett</i>	bark		Turk's Is. to New York	went ashore at New Inlet bar; later refloated
<i>J. W. Miner</i>	schooner		New York to Mobile	lost bulwarks; sails split
<i>J. W. Webster</i>	schooner		Charleston to New York	lost jibboom. boat, sails and deck swept by seas
<i>James Hendrickson</i>	schooner	Capt. Westcott	Petersburg to Philadelphia	put into Norfolk, leaking
<i>Jamestown</i>	steamship		New York to Norfolk (?)	took in water; cargo damaged
<i>Jenny Rogers</i>	brig		Campeche to -	lost bowsprit, jibboom, topgallant and topmasts
<i>John H Rhoades</i>	brig		Boston to Baltimore	blown ashore south of Cape Henry
<i>John Parker</i>	bark	Capt. Roberts	New Orleans to Rotterdam	went ashore on North Carolina coast; total loss

Hurricane Alley

VESSEL NAME	TYPE	MASTER	ROUTE	REMARKS
<i>John W. Merrill</i>	schooner		Solomon to —	
<i>John W. Miller</i>		Capt. Beay	Mobile to New York	
<i>Joseph Whitney</i>	steamship	Capt. Howes	Baltimore to Boston	
<i>Leocadia</i>	schooner	Capt. Diggs	Baltimore to Jamaica	
<i>Leon</i>	bark		Cadiz to Havana	put into Charleston for repairs
<i>Lexadia</i>	schooner		Baltimore to Jamaica	put into Norfolk in distress
<i>Liberty</i>		Capt. Adkins	New Orleans to New York	sprung a leak; some cargo overboard; sprung mainmast; twisted rudder head
<i>Luzon (Spanish)</i>	brig	Capt. de Uris	Havana to Falmouth, Eng.	went ashore near New Topsail Inlet; total loss
<i>Lydia B. Cowperthwaite</i>	schooner		Charleston to New York	put into Norfolk in distress
<i>M. P. Wilbur</i>	brig			
<i>Maria Morton</i>	brig	Capt. Thompson	Savannah to New York	lost mizzenmast, stove bulwarks and head rails; sprung leak; some cargo overboard
<i>Marine</i>	brig	Capt. Burt	Cardenas, Cuba to Boston	lost sails; sprung leak; rescued survivors of <i>Central America</i>
<i>Mary</i>	brig		Cardenas to Queenstown	rescued 3 survivors of <i>Central America</i> 9 days after sinking
<i>Mary Alice</i>	schooner		Havana to New York	stove bulwarks, lost jibboom and sprit sails
<i>Maryland</i>	steamship		Norfolk to Washington	
<i>Matthew Vassar, Jr.</i>	schooner		New Bedford to Baltimore	split mainsail
<i>Melvin</i>	brig		Jamaica to Boston	sprung leak; lost sails and cargo
<i>Moransey</i>	brig	Capt. Tinker	Mayaguez to New York	sprung leak; split foretopsail
<i>Mungo Park</i>	brig	Capt. Nichols		
<i>Nashville</i>	steamship	Capt. Murray	New York to Charleston	lost seaman, overboard
<i>New Republic</i>	schooner		Philadelphia to Wilmington	went ashore near Swansboro, NC
<i>Norkolk</i>	steamship	Capt. Kelly	Philadelphia to Richmond	founded in Chesapeake Bay; total loss; no lives lost
<i>North State</i>	schooner		Savannah to New York	sprung leak
<i>R. C. Stannard</i>	schooner		at anchor Beaufort, NC	dragged anchors; went afoul of <i>Charles McClue</i> ; both went ashore
<i>Richard</i>	bark		Honduras to New York	lost fore and main topgallant masts; split sails
<i>S. J. Waring</i>	schooner		Savannah to New York	lost boat, center house; stove bulwarks; decks swept by seas
<i>Samson</i>	brig		Key West to New York	split sails
<i>Sarah A. Nickels</i>			Baltimore to Montivideo	lost anchors in Chesapeake Bay
<i>Southerner</i>	steamship	Capt. Robertson	New York to Savannah	lost wheelhouses, 2 boats, stack; sprung leak; put into Charleston
<i>Spray</i>	steamship		Wilmington to Smithville	forced on the beach
<i>Spring Hill</i>	schooner		Rio Hache to Boston	lost mainmast
<i>St. Louis</i>			New Orleans to New York	lost sails; stove boats and bulwarks; cabin windows smashed
<i>State of Georgia</i>	steamship	Capt. Garvin	Philadelphia to Charleston	
<i>Vermont</i>	brig		Picton to Boston	lost
<i>Vespasian</i>	bark			
<i>Wake</i>	schooner	Capt. O'Brien	Wilmington, NC to New York	lost with cargo
<i>Warren Goddard</i>	brig	Capt. Ruhl	Aux Cays to New York	lost foretopgallant mast and load of logs; stove bulwarks; split sails
<i>William A. Ellis</i>	schooner			
<i>William Badger</i>				
<i>William Jenkins</i>	steamship		Boston to Baltimore	reported heavy gale



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North Atlantic Weather January, February and March 1991

January—The Icelandic Low was bristling this month. A 988-hPa center, over the tip of Greenland, signaled not so much an increase in the number of storms as it did a small number of particularly intense storms. This activity resulted in negative anomalies of down to -8 hPa around Kap Farvel, Greenland.

The month opened with a 968-hPa system just off Kap Farvel. To the south southeast, the V2QU reported 60-kn westerlies with a 976-hPa pressure. The storm intensified and the following day was down to 950 hPa, moving through the Norwegian Sea. It was only a few days later when a wicked North Atlantic Low whipped through the northern British Isles. On the 5th, near 58°N, 12°W, its central pressure was estimated at 951 hPa. Winds from a host of vessels were ranging from 45 to 55 kn and seas ran up to 30 ft. Just 4 days later, a 964-hPa system pounded the British Isles from the southwest.

One of the most potent storms in January formed over the southern U.S. on the 6th. It emerged over water by way of the Carolinas and really organized off Newfoundland on the 11th. Its central pressure was in the 950-hPa range on the 11th and 12th, and ships were measuring 40- to 50-kn winds during this period as the center skirted the 50th parallel between 150° and 35°W. At 1800 on the 11th, the *Demyansk* (47°N, 46°W) measured 58-kn southwest-erlies and a 964-hPa pressure in 26-ft seas. The storm turned northward but weakened before it moved across Iceland on the 14th.

The second half of the month seemed to be less active than the first half, and much of this activity was confined to north of 60°N. On the 21st a 968-hPa system was dominating the Denmark St, while a storm that would become dangerous was forming in the Foxe Basin north of Hudson Bay. This system moved into the Labrador Sea on

the 25th, where it quickly deepened. By 1200 on the 26th, its central pressure dipped to 966 hPa and it fell to 955 hPa some 24 hr later, as it moved up the west coast of Greenland. Luckily, it was well north of most of the shipping, although several vessels to the south did report 40-kn winds on the 26th. The month came to a close with a 975-hPa system just east of Kap Farvel.

Casualties—On the 5th and 6th gales gusting to 100 mph swept through the British Isles leaving at least 28 people dead. Among the dead were several Swiss tourists, 10 crew members of a Maltese registered ship and a Spanish sailor on another vessel. The Maltese registered, 1,000-ton *Kimya* was sailing for Spain from Liverpool with a cargo of sunflower oil when it capsized off the British coast. The rig stand-by vessel *Britannia Stallion* took 20 hr to make the 35-mi trip to the safety of Hull docks after she

was holed in her bow in a collision with a drilling rig. The 1,236-ton Panamanian reefer ship *Omagh* was driven aground in Carlingford Lough. The trawler *Greenland* was located after a search, and was found severely damaged near 52°N, 14°W. The wheelhouse was missing and power was lost. The trawler *Toki Argia* was alongside. Also suffering heavy weather damage was the cross Channel ferry *Fantasia*, while attempting to berth at Dover. The Norwegian reefer ship *Jarl* missed the entrance to her dock in Esbjerg and went aground on the rocks. The Irish containership *Wicklow* reported losing four containers overboard between Rotterdam and Dublin.

On the 13th, the tug *Jessie Flowers* sank in the Ohio River, and losing control in flood-swollen waters as she tried to tow 16 mostly empty barges past a dam at Smithland, KY.

February—January's pressure pattern continued right into February. The Icelandic Low was more dominant than usual. This was reflected in anomalies which dipped to -10 to -14 hPa from Kap Farvel to Baffin Bay. Negative anomalies also extended southeastward to Ireland and covered Hudson Bay and the Great Lakes in the west.

All this points to a cyclonically active February. A glance at the track chart doesn't indicate anything so terrible, which almost always means the storms that did occur were severe. This was the case in February. There were four systems south of Kap Farvel whose central pressures were estimated below 960 hPa. The first one took place on the 1st of the month, when a storm left over from January deepened rapidly to 950 hPa near

57°N, 47°W (above). Ship reports testify to the power of this storm. At 0600 the *Irving Ours Polaire* (47°N, 56°W) measured 165-kn westerlies, while the *Frithjof* farther east ran into a measured 54-kn west southwesterly in 20-ft seas. Earlier the *Atlantic Cartier* (46°N, 43°W) registered 65-kn south southeasterlies in 23-ft seas, which by 1200 increased to near 30 ft. This storm can safely be called the *Monster of the Month*. It continued to terrorize shipping throughout the 1st. Reports of 30-ft swells and 50- to 60-kn winds were received. The storm filled only slightly as it made its way through the Denmark St during the next few days. Gale and storm force winds continued to come in. It wasn't until the 5th that some order was restored.

Another significant contribution to the Icelandic Low was made on the 14th. A low that began off Georgia on the 9th, exploded, meteorologically speaking. A 978-hPa center, at 1200 on the 13th near 50°N, 50°W, became a 956-hPa center 24-hr later after crossing the 55th parallel, heading into the Labrador Sea. An early indication of the storm's potential was provided by the WZJD (137°N, 60°W) at 1800 on the 12th, when she reported 50-kn northwesterlies in 19-ft seas. This was verified by several vessels the following day. However, it was at its worst on the 14th when it was northeast of most reporting ships and there is very little indication of just how potent this storm was, except for the low pressure.

Things were relatively quiet for a couple of days before a dynamic duo appeared on the scene. One of these storms intensified off Newfoundland on the 23d, after traveling across the northern U.S. and southern Canada. The other system formed just south of Hudson Bay on the 20th and start-



Satellite Data Services Division

This is the Monster of the Month for February. It actually formed in January, but really played havoc with shipping early in February. It is shown here on the 1st at about 1500 UTC when its central pressure was estimated at about 950 hPa.

ed to intensify on the 21st, near 50°N, 43°W. The Hudson Bay storm had a 957-hPa center by the 22d after crossing the 35th meridian near 52°N. Some 2 days later, the Newfoundland system was about 300 mi to the west of this spot and sporting a 956-hPa center. This resulted in a period of hectic weather over the northern trade routes. Later on the 21st, several vessels in the area were reporting winds in the 40-kn range with 20-ft swells. At 0600 on the 22d, the *Frithjof* (55°N, 22°W) was nailed by 51-kn east southeasterlies in 17-ft seas and reported a 966-hPa pressure. Storm force winds remained common throughout the day. On the 23d, the Hudson Bay storm turned eastward, while the Newfoundland system headed east northeastward in its wake. Winds in the 40- to 50-kn range continued to blow throughout the day south and east of Kap Farvel. At 0600 on the 24th, the VC9450 (50°N, 50°W) measured a 60-kn northwesterly in

visibilities that had dropped to 50 yd in continuous heavy snow. A short distance away the CG62959 sent in a 965-hPa pressure. There were several other 60-kn wind reports during the day and even into the following day, as the Labrador storm recurved into the Denmark St and remained potent.

Casualties— On February 1st the tanker *Alessandro Primo* sank in a storm in the Adriatic, but her 14 crew members were rescued. Officials said the vessel sank in force 7 winds about 19 mi off Molfetta, Italy. On the 2d and 3d, hurricane force winds swept over Iceland in conjunction with the 950-hPa storm. Coastal residents and the fishing industry were warned in advance of the storm and took necessary precautions.

March— Usually the Icelandic Low dominates the scene and the Azores-Bermuda High is nowhere to be seen. However, this year the Icelandic Low was impressive and more intense than normal. It spread negative anomalies from Newfoundland to Spain. To the south, a subtropical high established itself in a pattern that was more reminiscent of May than March.

A look at the track chart makes it appear that the Icelandic Low was made up of a large number of weak to moderate systems rather than a few intense ones, as in previous months. However, there were a couple of potent storms worth mentioning (right).

Like February, the month opened with a wicked storm south of Kap Farvel. At 1200 the central pressure was estimated at 959 hPa near 57°N, 38°W. This system was

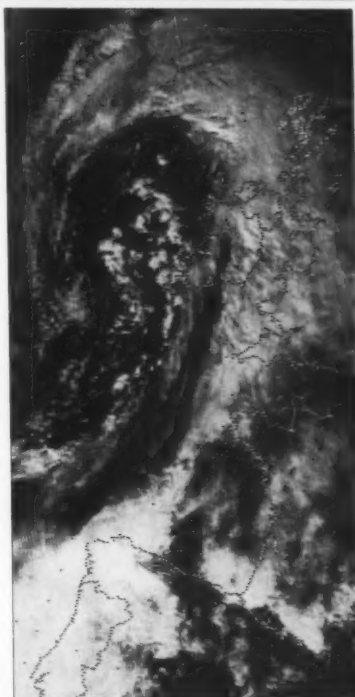
responsible for a couple of rough days in this area and was quickly followed by another system. Wind speeds ran 40 to 60 kn, combined with moderate to heavy snow in swells that ranged from 20 to 30 ft. These conditions were prevalent on the 1st and 2d, and could be testified to by reports from the *V2QT*, *Greenland Saga*, *Hofsjokull* and the *Polyarnmy Krug*.

On the 4th a 960-hPa Low was spotted near 55°N, 35°W. The OVSH2 (47°N, 39°W) measured a 46-kn west northwest wind at 0000 on the 4th. The *Arctic* measured a 44-kn east northeast wind and a 969-hPa pressure. This storm filled slightly as it headed southeastward during the 5th and 6th. However, in an interesting turn of events, it swung northward on the 8th and moved into the Irish Sea.

Another system moved across the British Isles on the 16th and 17th. It had begun east of Florida on the 9th. By the 11th its central pressure was down to 966 hPa as it moved northward. The following day it turned a counter-clockwise loop over Nova Scotia and headed eastward. By the 13th it had filled to 990 hPa. Earlier, on the 11th at 2100, the *Oryos* (k47°N, 56°W) measured a 65-kn northeasterly in heavy snow that was reducing visibility to 50 yd. They also had a pressure reading of 979 hPa. Several other reports verified these conditions. The system, which had weakened on the 13th, retained its identity and then deepened somewhat on the 16th as it approached the British Isles.

The last half of the month was cyclonically active, but storms were less furious than the preceding ones. While this activity was spread across the North Atlantic, a large number of Lows roamed the Baffin Bay area.

Casualties—Reports of a freak



Satellite Data Services Division

This was the storm that plagued shipping during the first 2 days of the month. It is shown here on the 4th, still active, as it moves into the British Isles. Meanwhile, a 960-hPa Low is taking up the slack to the west and will eventually move into the Irish Sea.

whirlwind in western Wales left a 20 mi swath of damage and destruction on the 3d. Heavy weather damage to the crane barge *Riya 1* in the Aziza area of Saudi Arabia was reported to have occurred on the 15th.



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North Pacific Weather January, February and March 1991

January—The Aleutian Low was true to form and dominated most of the North Pacific. Its center, however, was east of its normal position, resulting in positive pressure anomalies to the north and northwest. These were further enhanced by an extension of the Siberian High.

The storm tracks, which made up the Aleutian Low, reflected this displacement. Not too many storms made it into the Bering Sea or Gulf of Alaska, but several intense systems affected the northern shipping lanes.

On the 5th a system came to life east of Tokyo and didn't dissipate until the 23d over Greenland—in the North Atlantic. It turned a large counterclockwise loop from the 7th through the 13th, south of the Aleutians. During this period it was most intense as the central pressure fell to 960 hPa, or below, from the 7th through the 9th. On the 7th, a multitude of vessels reported winds

in the 40- to 50-kn range in seas of 10 to 20 ft. A good report, typical of many, was received from the *Washington Rainbow ii* (54°N, 177°E) at 1800 on the 7th. They measured a 52-kn wind in 18-ft seas and a 985-hPa pressure. The following day several ships came in with winds in the mid 50-kn range, including the *Salusnavis* and the *Sea-Land Innovator*. Conditions seemed to ease somewhat on the 9th, and the following day the central pressure rose to 977 hPa. After filling to 990 hPa on the 13th, the system became more active as it neared the International Dateline near 42°N. The next day the central pressure dipped to 966 hPa, which may actually have been a new center forming. Nonetheless, the storm continued to plague shipping as it headed for the Gulf of Alaska. The XCMG didn't care whether it was a new center or not. All they were worrying about was the 58-kn winds they ran into near 40°N, 172°W in swells that were near 40 ft.

The storm approached the Gulf of Alaska on the 17th (right), sporting a 960-hPa center, and its influence was felt far to the south. The *Century Highway No. 5*, at 1800 on the 17th, measured 56-kn westerlies near 55°N, 150°W and reported 33-ft swells. There were several reports of storm force winds and they did not let up, because another storm was following to the west.

This system, which also came to life east of Tokyo on the 13th, was fairly quiet until the 17th at 1200, when its central pressure dropped to 968 hPa. It then nose-dived to 948 hPa in another 24 hr as it turned northward and headed for the Alaska Peninsula. So, on the 17th as one storm was deepening rapidly and another was moving across Alaska, the focus of gale and storm force winds shifted southwestward. A 960-hPa pressure was reported at 1200 on the 18th near 47°N, 166°W by the OYKS2, which estimated 70-kn northerlies in 46-ft seas. Several other vessels



Satellite Data Services Division

This system was heading toward the Gulf of Alaska on the 17th, when this photo was taken, but its influence was felt far to the south with a frontal boundary apparent.

measured winds in the 60-kn range, so this report was not out of line. The vessel continued to encounter hurricane force conditions for the next several hours. The system finally moved into Bristol Bay on the 19th.

However, by this time another potent storm had already formed over Hokkaido. By the 20th its central pressure was 944 hPa as it paralleled the 46th parallel between 165°E and 175°E. Several ships reported winds in the 40- to 50-kn range with gales of 15 to 25 ft. It turned northward on the 21st and moved into the Bering Sea.

Casualties—A 75-ft trawler sank northwest of Astoria, OR on the

11th in very rough seas. A Coast Guardsman was on board the sinking vessel with four fishermen when it submerged. Two fishermen were eventually rescued, but two others and the Coast Guardsman drowned. The next morning winds were still gusting to 65 mph at Youngs Bay Bridge.

February—The Aleutian Low was much deeper and farther to the southeast than normal. The negative anomalies dipped to near -6 hPa near 40°N, 160°W. Storm tracks for the month were strung across the Pacific from west to east in a band between 35° and 50°N. However, a couple of potent storms did make it into the Gulf of Alaska.

The 1st of the month seems to have been a hectic weather day in both oceans this winter, and the 1st of February was no different. A 954-hPa powerhouse was pounding the Alexander Archipelago and offshore waters as the month opened. The *Ace Accord* was caught by 40-kn winds and 15-ft seas near 56°N, 136°W. Several other vessels farther south were also feeling the sting of this storm. The coastal beating continued on the 2d as the system moved inland over Juneau, AK. The DESW1 (48°N, 125°W) measured 44-kn southeasterlies at 0000 on the 2d. The following day the system was out of harm's way.

Another significant storm had already formed east of the Kurils and was tracking eastward. On the 4th at 1200 its central pressure was estimated at 970 hPa; in 24 hr it dropped to 968 hPa and in 48 hr it was down to 953 hPa (right). By this time, 1200 on the 6th, it was crossing the International Dateline near 43°N. Once into the eastern North Pacific, however, it began to fill and swing northward. It actually

persisted until the 15th and made its way through the Bering Sea and into Siberia. Shipping was most affected on the 5th and 6th, when winds of 40 to 50 kn were measured in seas that were estimated at up to 30 ft. Actually, the *Neptune Pearl* measured a 65-kn west southwesterly on the 5th and the *Canadian Ace II* hit a 54-kn south southwesterly the following day. In fact, late on the 6th several ships reported in with 50-kn plus winds. Storm force winds lasted into the 7th, thanks to a 962-hPa center nearby. This system deepened rapidly to keep the weather miserable from the date-line eastward. It followed on the heels of the previous storm and, on the 8th, near 45°N, 170°W its central pressure was down to 960 hPa. However, instead of recurving it shifted and headed eastward. Luckily, it also began to fill. On the 8th it was responsible for winds in the 40- to 55-kn range. At 1800, the NGDF hit measured 54-kn norther-



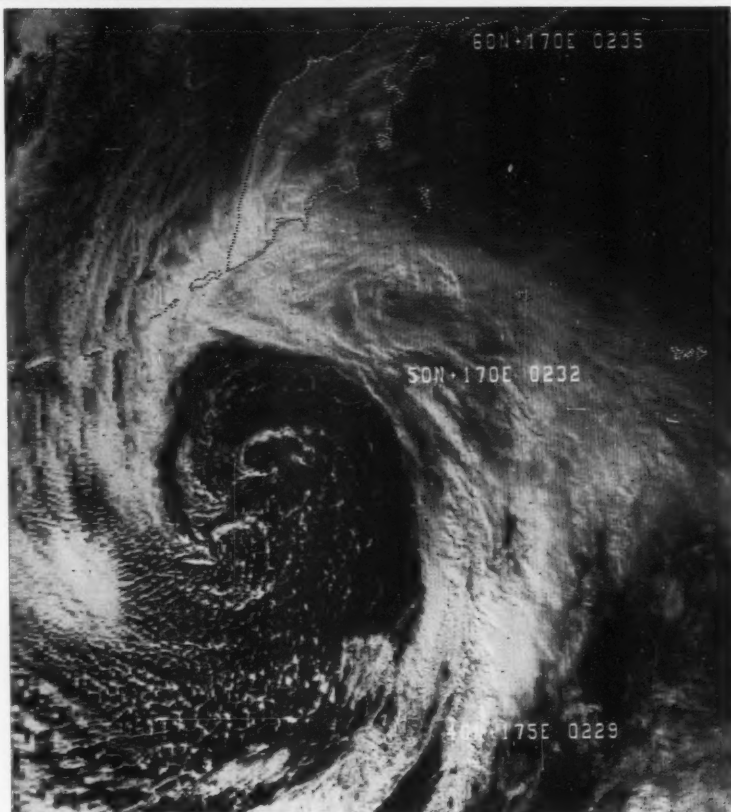
Satellite Data Services Division

On the 6th this was as potent a storm as the photograph shows.

lies near 54°N, 170°W in 26-ft swells. Activity was lighter during the second half of the month. However, there was a 956-hPa Low on the 17th near 43°N, 155°E and a 968-hPa system roamed the waters east of the dateline on the 25th and 26th. The 965-hPa system formed over Honshu on the 15th and deepened rapidly as it headed east northeastward. By the 17th, winds in the 40- to 55-kn range were common. One vessel, the *Komandor* (45°N, 147°E), measured a 64-kn northerly, while farther to the south the *Eden* hit a 54-kn northerly in 20-ft swells. The storm turned northeastward and began to fill on the 18th.

On the 22d, a system developed northeast of Honshu and moved toward the east northeast. By the 25th, after an eastward shift, it intensified into a 968-hPa Low. At 0600 the *Aya II* radioed in a measured 56-kn northwesterly near 54°N, 163°W. In general 40- to 50-kn winds were being experienced in 15- to 30-ft swells. This continued into the 26th.

Casualties—A series of storms moved through southern California in late February, resulting in heavy rainfall and mudslides. One death occurred when three people were rafting down the Santa Ana River and a young girl fell off the raft. A faint Mayday call in the Bering Sea on the 10th led to an all day search for the *Barbarossa*, with at least six people on board. The *Frontier Mariner*, 10 mi off the Pribilof Is of St George, was one of three vessels to pick up the message. The Coast Guard believes it sank about 14 mi southeast of St George, where winds were blowing at 35 kn with freezing spray and 14-ft seas.



Satellite Data Services Division

March—Two things stand out on the track chart for this month. The lack of action in the central North Pacific and the concentration of storms in the northwestern part of the basin. One look at the mean pressure chart for March and the results of these two features are obvious. The Aleutian Low is squeezed into the western Bering Sea and the Pacific subtropical high is unusually large for this time of the year. Pressure anomalies of up to -10 hPa and +18 hPa indicate the drastic change from normal. There were also a number of systems that hit the West Coast of the U.S. and the adjacent coastal routes.

The northwest Pacific was the scene of the action, and some of it was intense. On the 8th, a 960-hPa storm rambled northward into the Bering Sea as it paralleled the 170°E meridian. It was followed a few days later by a 956-hPa Low. This in turn was followed, on the 15th by a 962-hPa storm. The result—a week or more of rough weather over the northern trade routes, particularly the western portions. It actually began on the 6th when the LAGG2 (46°N, 170°E) came in with 45-kn winds in 10-ft seas. There were several reports on the 8th of 50- to 60-kn winds. In fact, the *Aya II* (44°N, 161°E) measured a 64-kn westerly at 1200 on



Satellite Data Services Division

The photo on the preceding page and the one above show two of the intense storms that brought grief to mariners who sailed the northern trade routes in March. The first one was taken on the 8th when the storm's

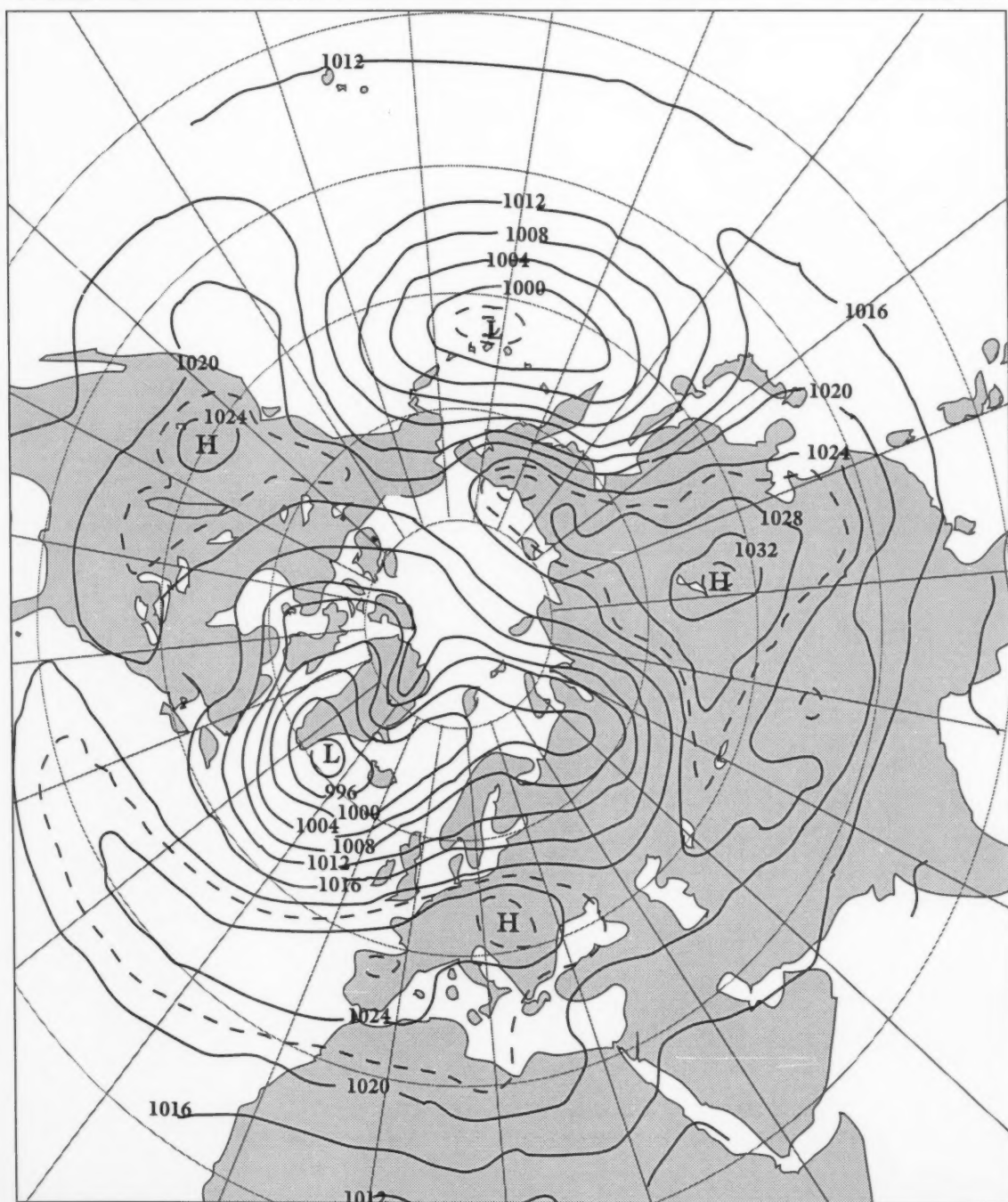
central pressure was estimated at 960 hPa. The photo above was the next storm in the series on the 11th and was generating 40- to 50-kn winds along the sharp frontal boundary.

the 8th in moderate to heavy snow showers. They estimated the seas at about 40 ft. Conditions improved slightly on the 9th. After a short break, the weather deteriorated again on the 11th as winds in the 40- to 50-kn range accompanied the 956-hPa storm. On the 14th, the *Professor* (54°N, 156°E) measured a 58-kn easterly and there was no improvement on this area for the next 4 days. The *Star Hong Kong*, in a series of reports on the 15th and 16th, indicated winds in the 70- to 75-kn range in 10- to 23-ft swells near 51°N, 174°E. They experienced a variety of weather during this stretch, including squalls and snow. The general movement of these systems was northerly. Several Lows made it into the Gulf of Alaska, but fortunately none was that potent. The barrage in the northwestern North Pacific continued during the second half of the month although the Lows were severe. See page 49 of the Spring issue of the *Mariners Weather Log* for an excellent summary of the storm that hit St. Paul Is.

Casualties—A series of Pacific coastal storms early in the month brought high winds to the Oregon coast. During the first storm, Sea Lion Caves reported wind gusts to 61 mph, Gold Beach to 65 mph and Cape Blanco to 75 mph on the 2d. Another storm in the series, on the 3d, caused 91-mph gusts at Cape Blanco Lighthouse, while Gold Beach had gusts to 82 mph. Minor damage was reported along the Oregon coast and sustained winds of 40 mph in Portland were enough to capsize a sailboat on the Columbia River.

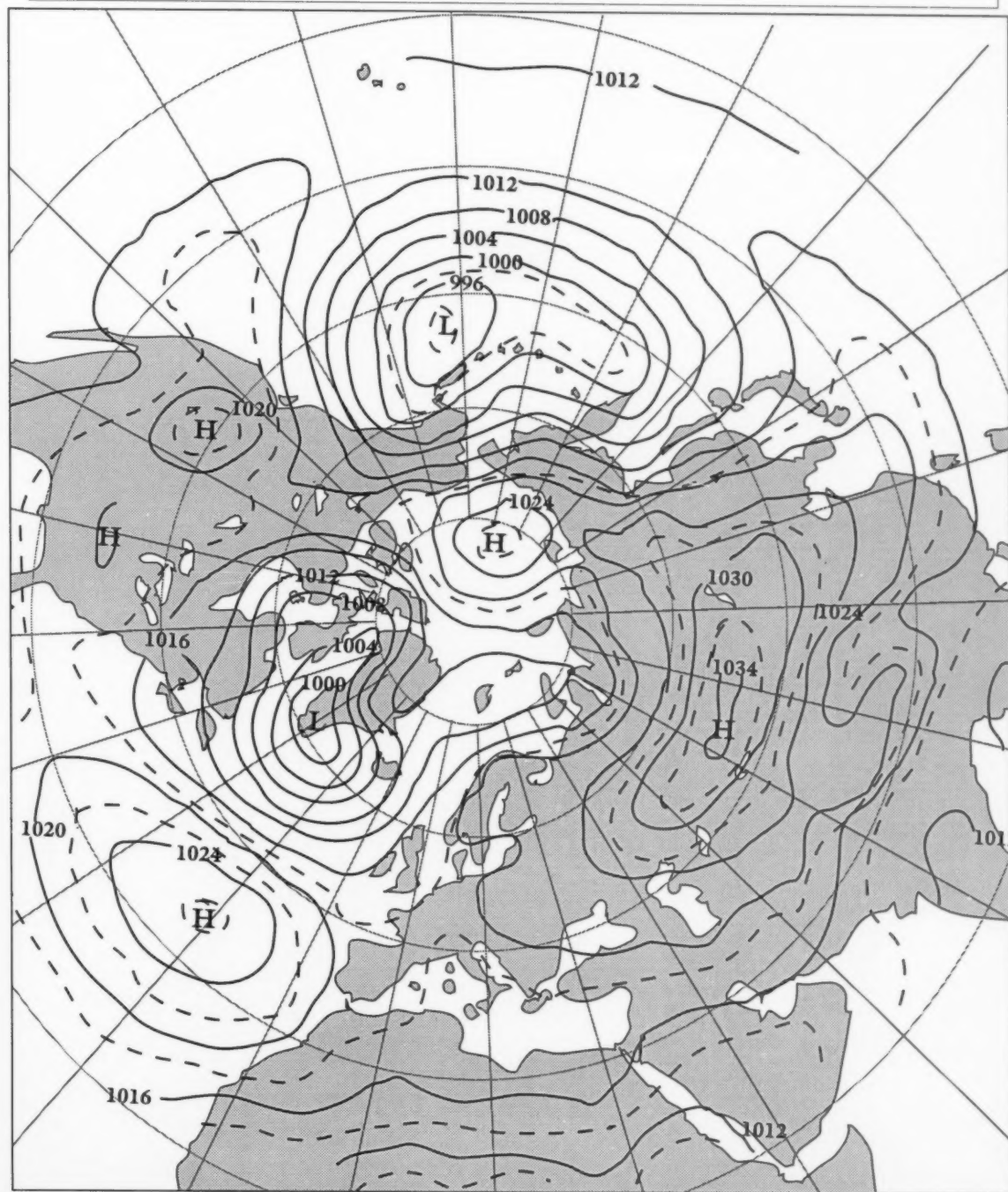
Mean Monthly Sea Level Pressure

January 1991



Mean Monthly Sea Level Pressure

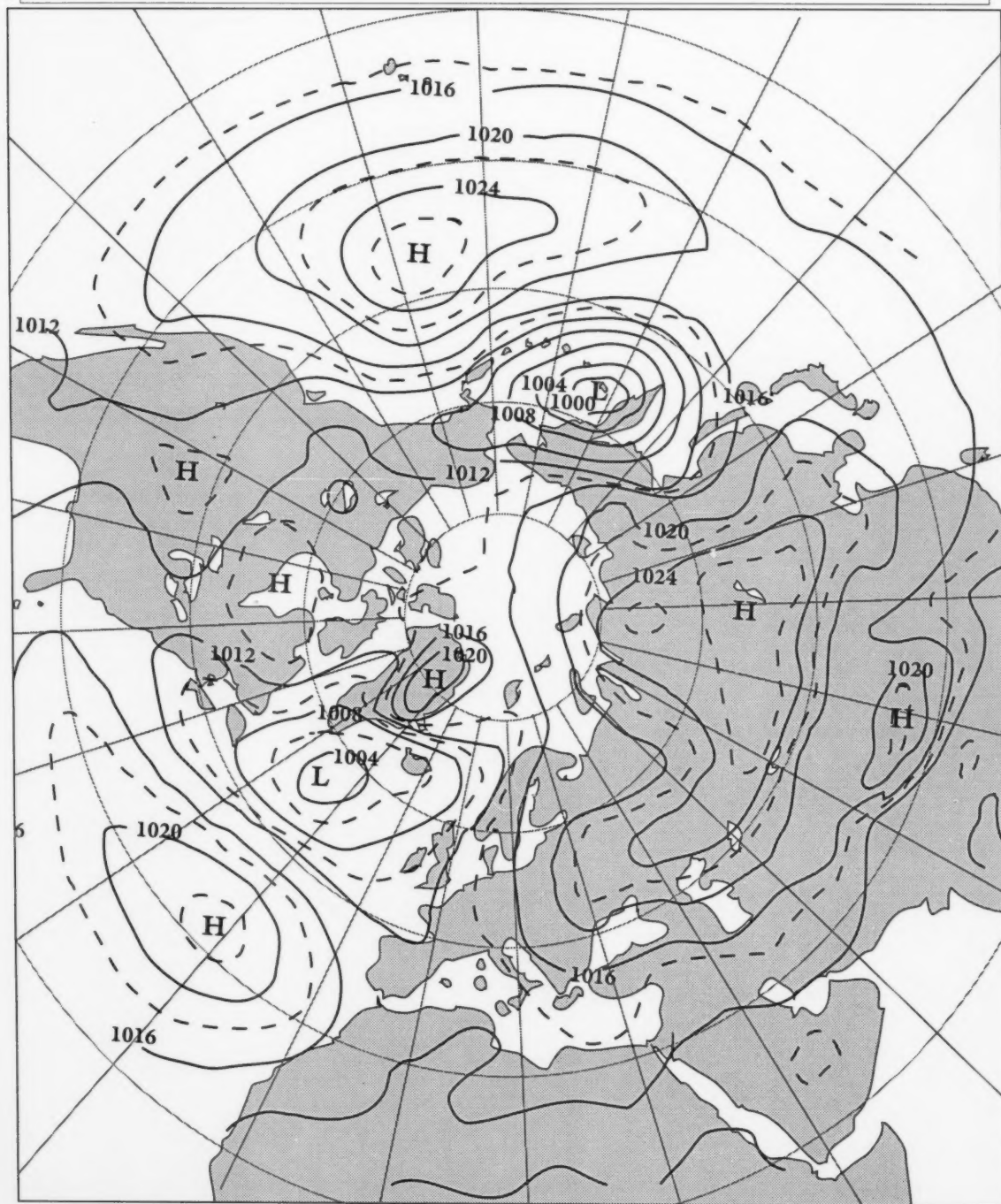
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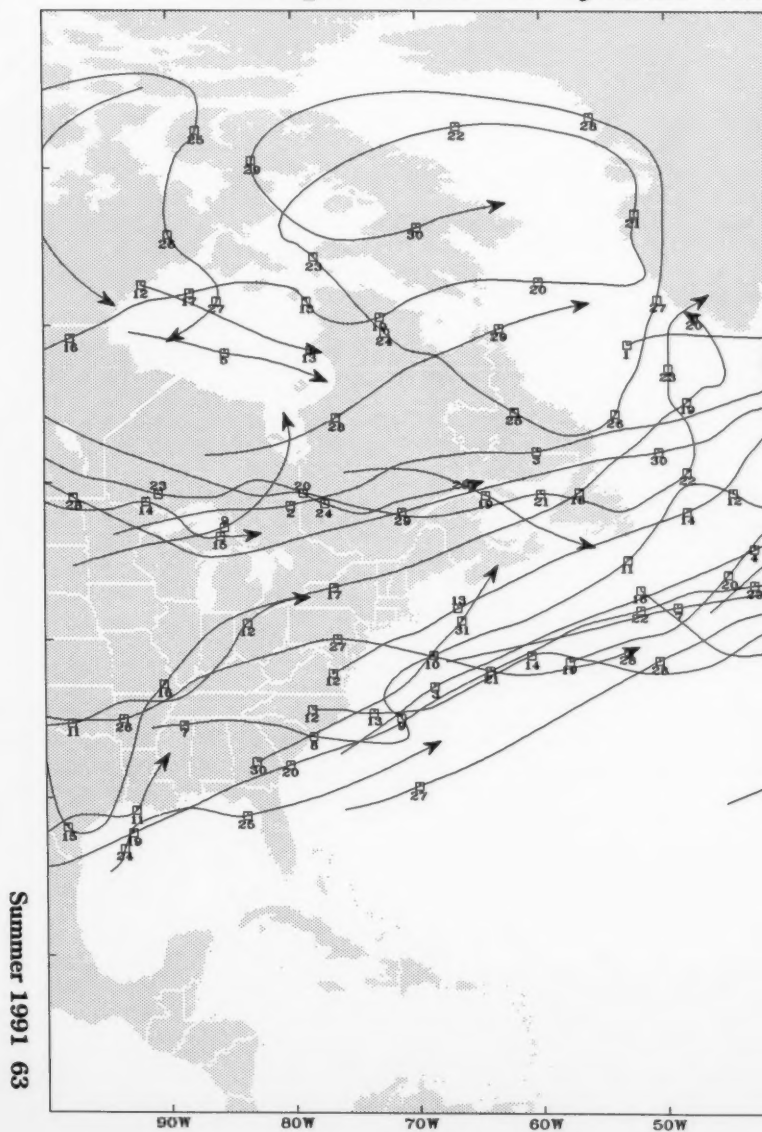
Summer 1991 61

Mean Monthly Sea Level Pressure

March 1991

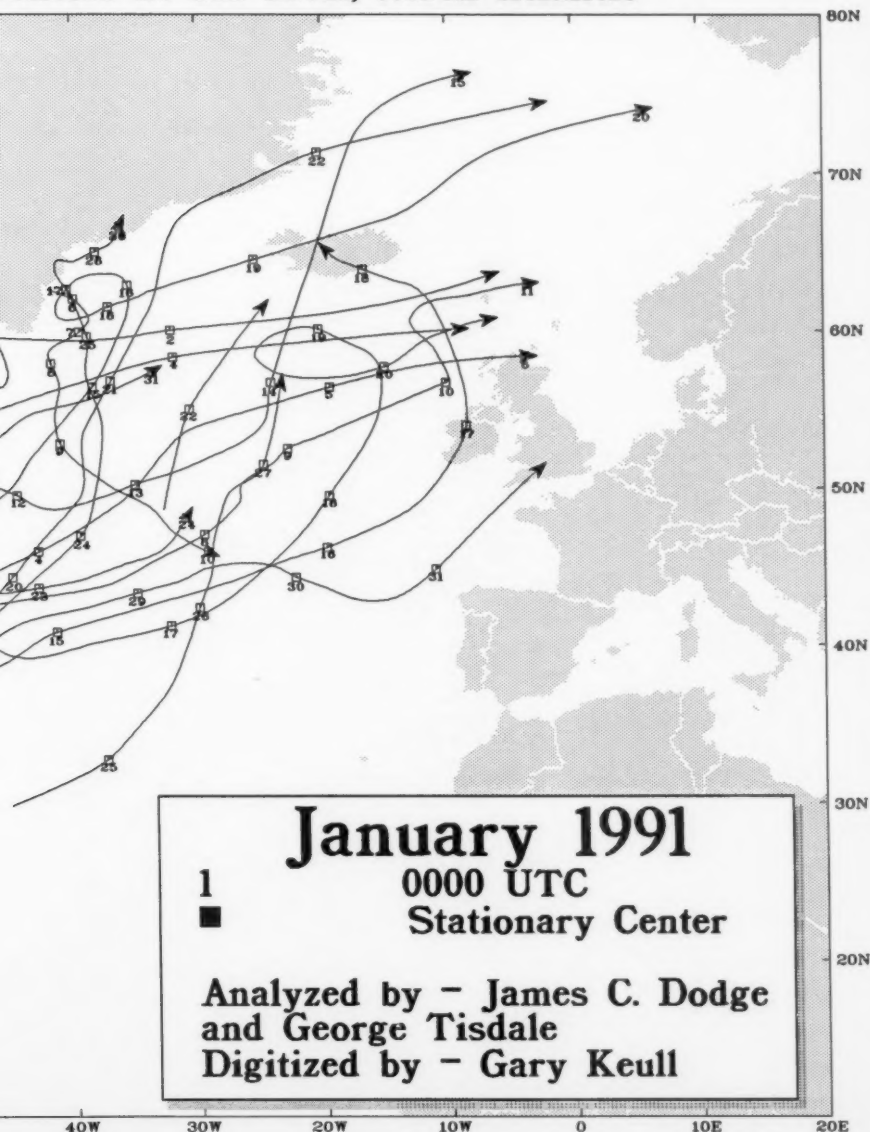


Principal Tracks of Cyclone Cen



Summer 1991 63

Centers at Sea Level, North Atlantic

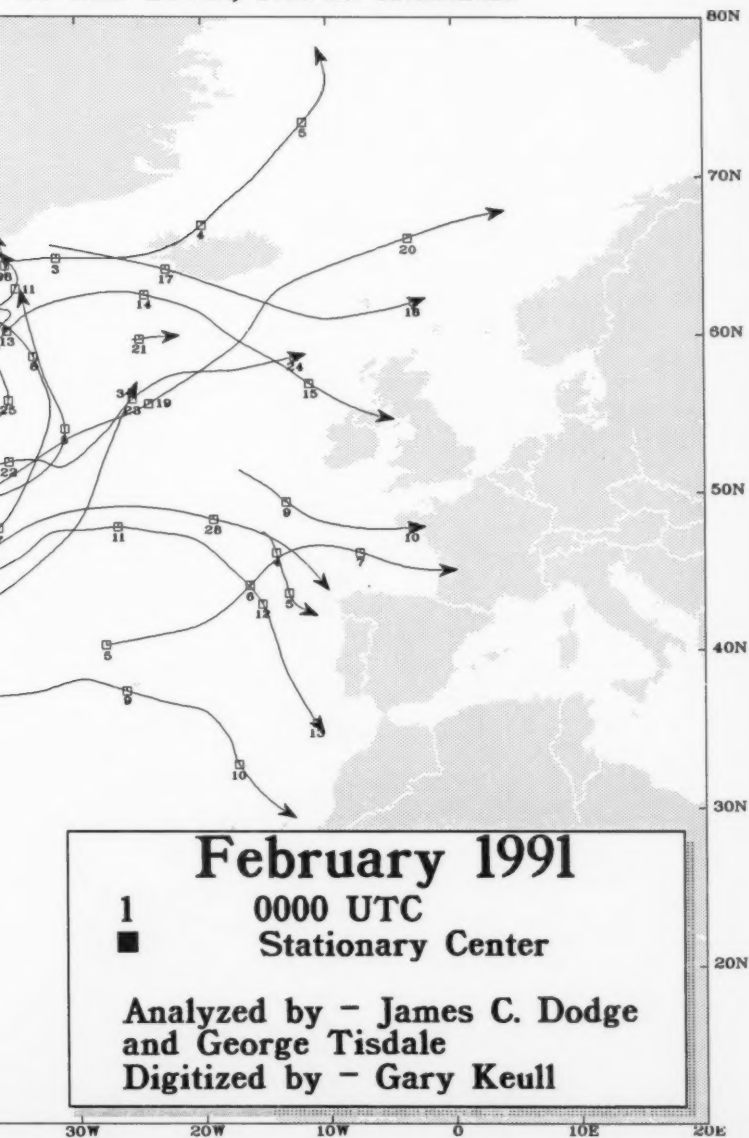


Principal Tracks of Cyclone Centers at

64 Marine Weather Log



at Sea Level, North Atlantic

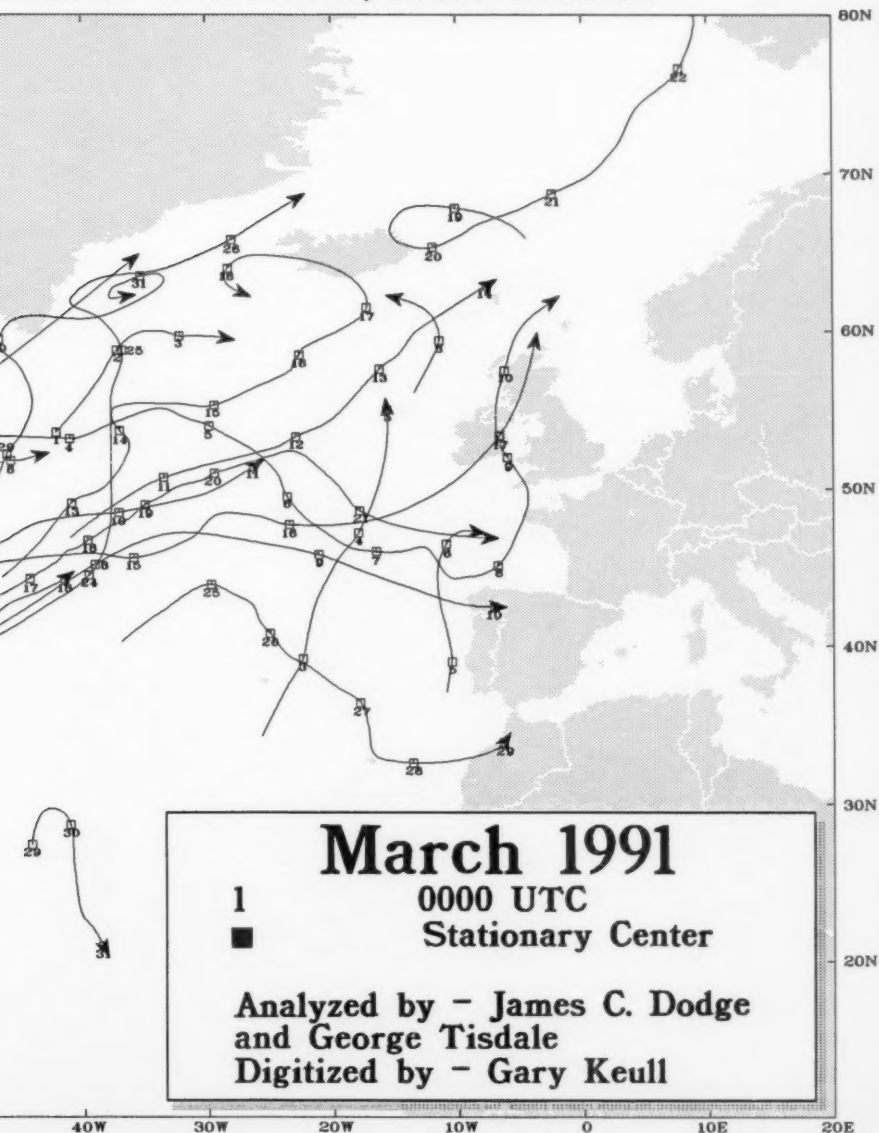


Principal Tracks of Cyclone Centers

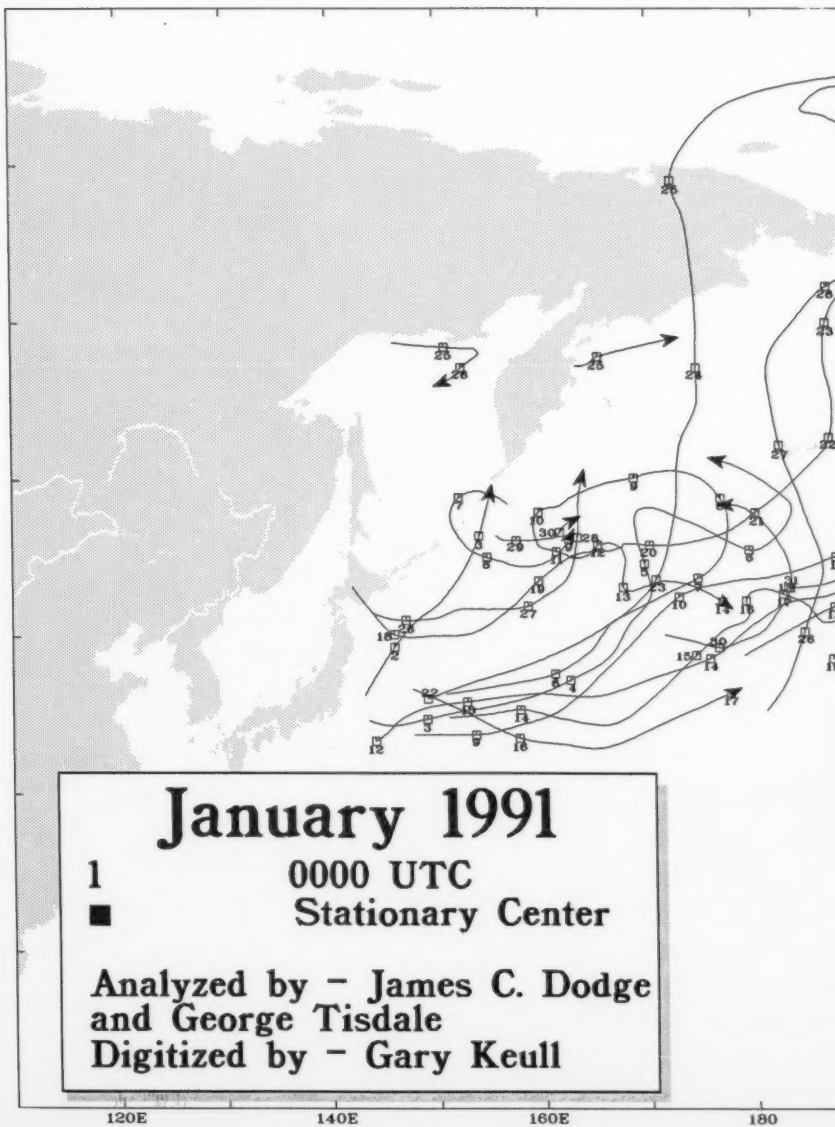
Summer 1991 65



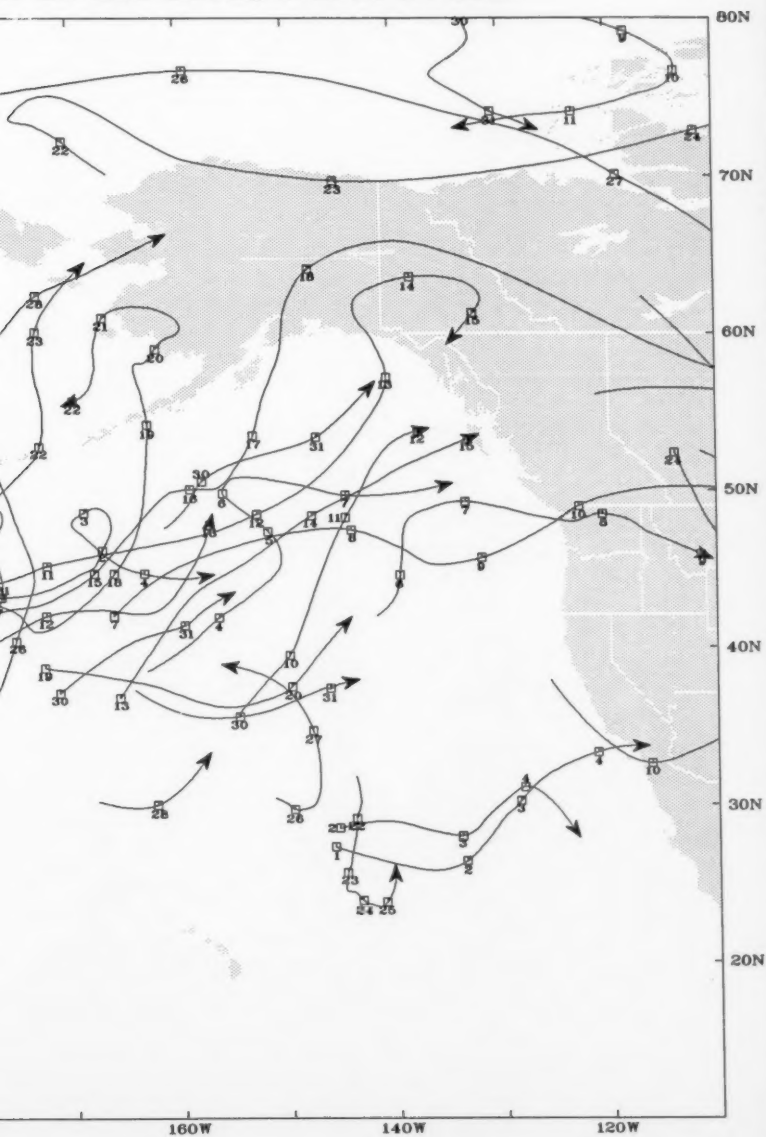
Centers at Sea Level, North Atlantic



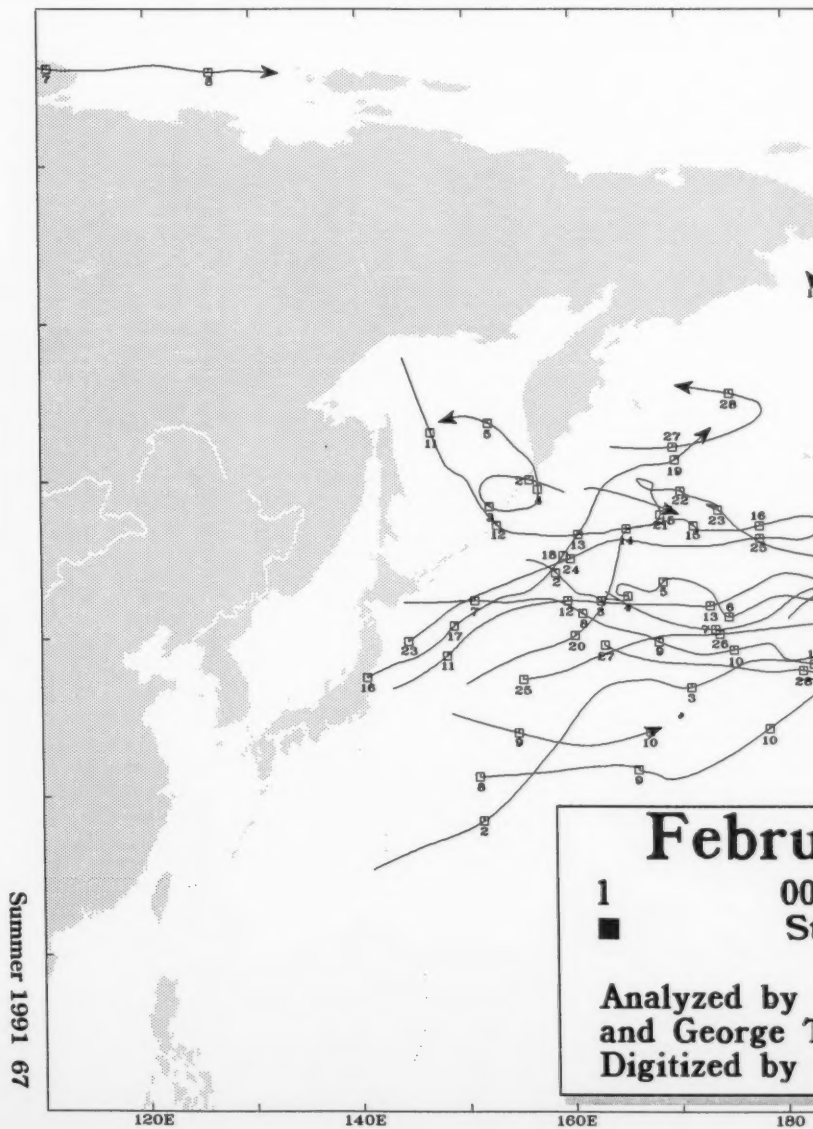
Principal Tracks of Cyclone Centers



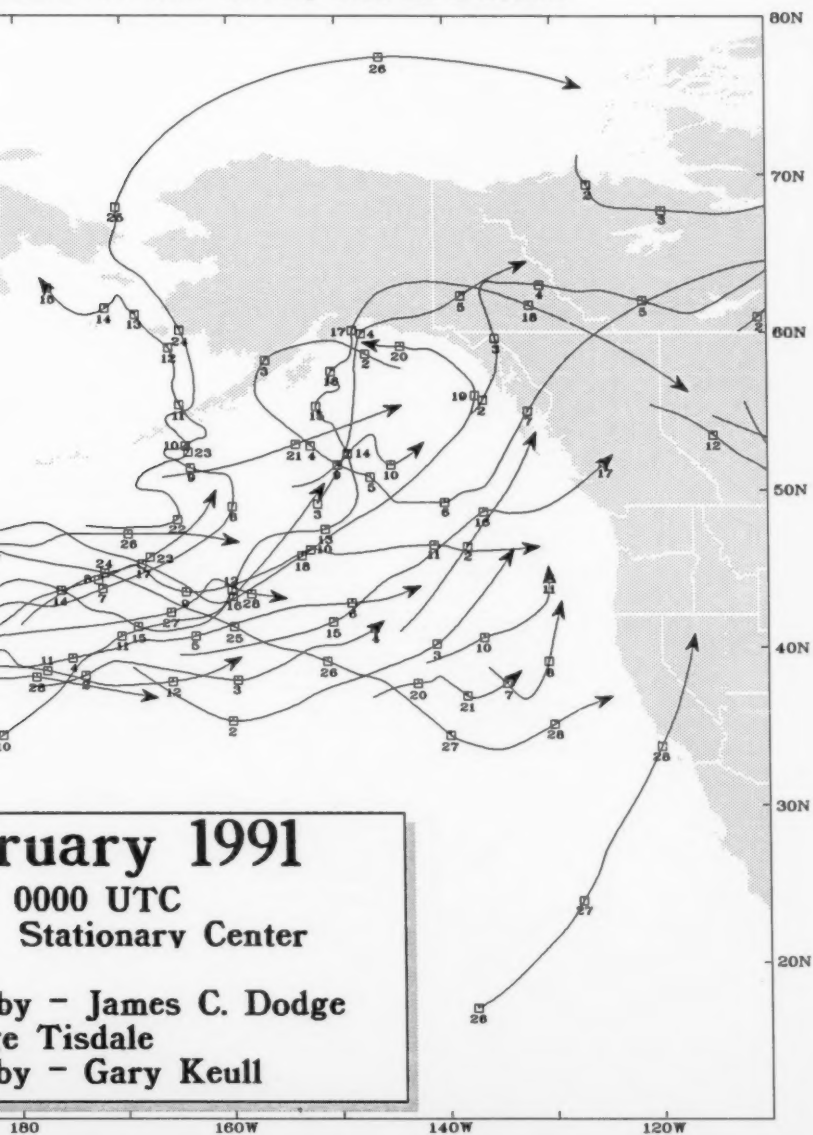
Currents at Sea Level, North Pacific



Principal Tracks of Cyclone Center

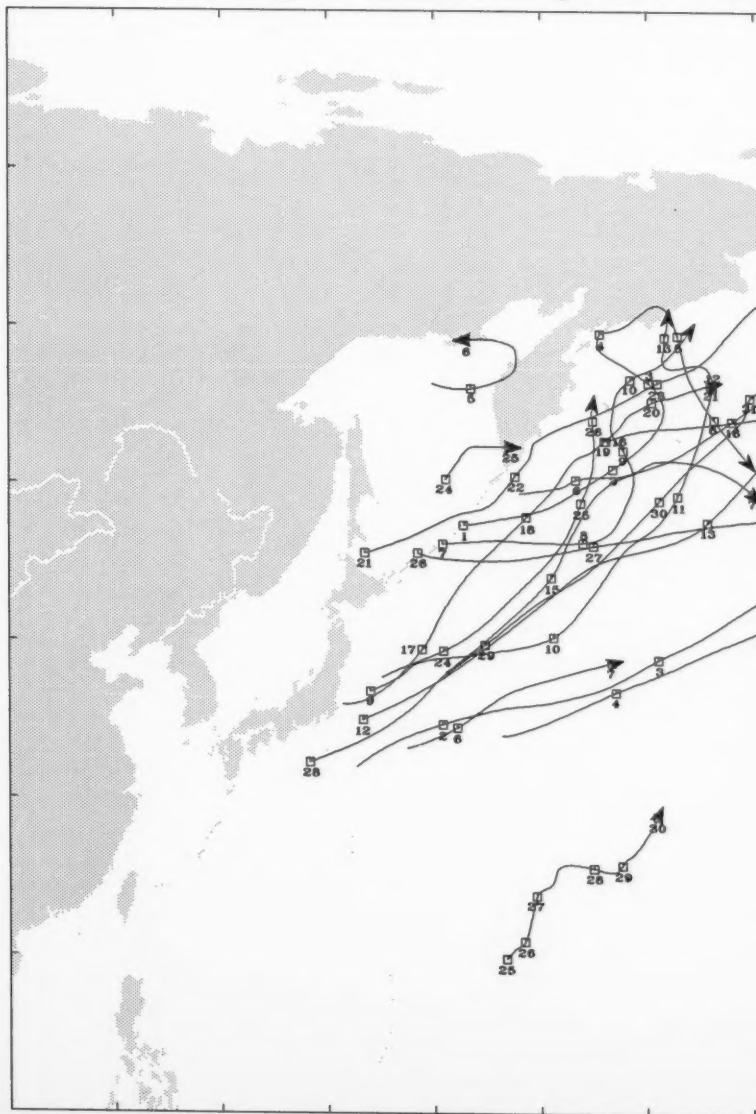


Waters at Sea Level, North Pacific

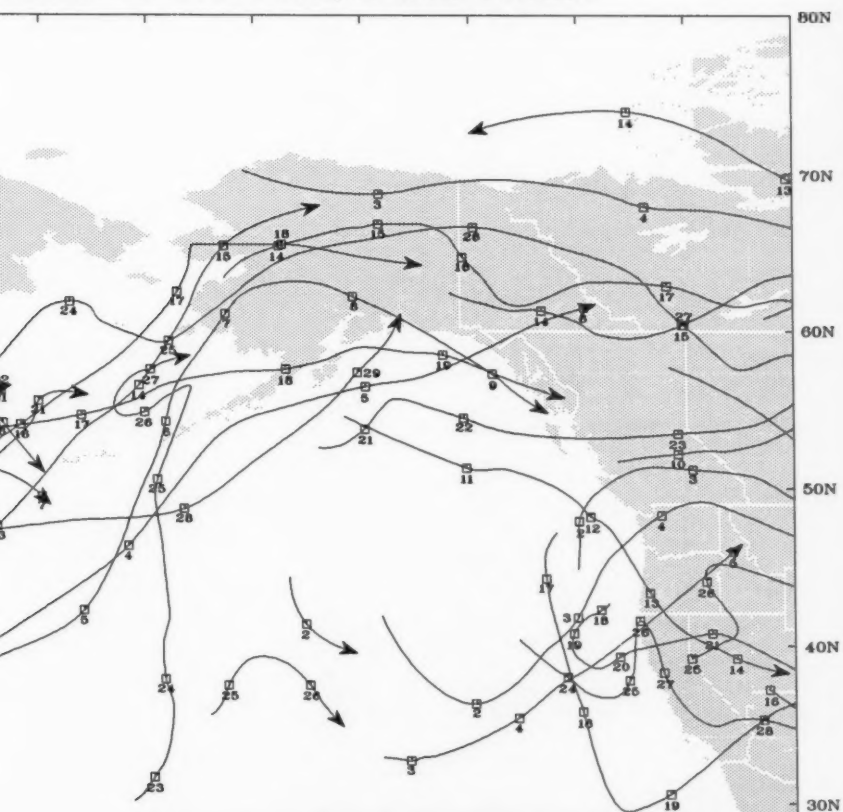


Principal Tracks of Cyclone Cent

68 Marine Weather Log



Centers at Sea Level, North Pacific



March 1991

0000 UTC

Stationary Center

1



**Analyzed by - James C. Dodge
and George Tisdale
Digitized by - Gary Keull**

Selected Gale and Wave Observations

January, February and March 1991

VESSEL	CALL	DATE	POSITION		WIND		VSBY	PRES WX.	PRESS- URE	TEMP deg C.	SEA WAVES		SWELL WAVES			
			LAT.	LONG.	TIME	DIR.					SPEED	PD.	HGT.	DIR	PD.	HGT.
			deg.	deg.	GMT	10 deg. kn.										
PACIFIC JAN.																
SEALAND INNOVATOR	WGKF	6	35.2 N	144.5 E	06	32	M 45	10 NM	15	1005.5	9.4	12		29.5		
PRESIDENT EISENHOWER	KRJG	8	36.7 N	155.0 E	00	29	M 50	5 NM	02	1002.0	12.0	14.7	8	24.5 29 10 32.5		
SEALAND INNOVATOR	WGKF	8	36.6 N	163.6 E	03	29	M 54	2 NM	26	0997.7	10.0		8	29.5		
PRESIDENT KENNEDY	WRYE	10	42.8 N	147.3 W	18	25	M 55	2 NM	12	0984.0	8.5	11.6	10	32.5 25 8 29.5		
MORELOS	XCMG	14	40.0 N	170.9 W	21	27	M 50	2 NM	18	0983.0	13.5	16.0	9	19.5 25 10 34.5		
CENTURY HIGHWAY NO. 5	8JPX	17	52.7 N	148.6 W	06	24	M 57	2 NM		0972.5	4.0	11.0	16	32.5 24 18 39		
PRINCE OF TOKYO 2	3EUU6	17	41.6 N	163.6 W	18	16	M 64	.25 NM		0980.9	12.0	6.0	34	39 16 35 41		
ANNA MAERSK	OYKS2	18	47.3 N	168.5 W	06	36	65	1 NM	83	0962.5	3.0	XX	39			
PRINCE OF TOKYO 2	3EUU6	18	42.8 N	159.1 W	12	21	M 64	2 NM	10	0988.0	10.0	6.0	8	26 21 14 29.5		
ANNA MAERSK	OYKS2	18	47.3 N	165.6 W	12	36	70	5 NM	83	0960.0	2.0	XX	46			
ANNA MAERSK	OYKS2	18	47.4 N	162.9 W	18	27	65	10 NM	83	0979.0	2.0	XX	42.5			
ANNA MAERSK	OYKS2	19	47.5 N	159.8 W	00	28	60	2 NM	83	0994.5	5.0	6.0	8	39		
PETROBULK PROGRESS	C6JK6	19	45.3 N	179.6 W	18	11	M 47	1 NM	84	0998.2		4.5	9	24.5 11 13 29.5		
NATIONAL DIGNITY	DZRG	26	40.1 N	148.0 E	12	25	M 48	5 NM	60	1001.0	6.0	6.0	5	19.5 25 8 29.5		
NATIONAL DIGNITY	DZRG	26	40.1 N	149.7 E	18	32	M 50	2 NM	50	1002.5	7.0	10.0	8	29.5 32 18 36		
JOVIAN LILY	DZDV	27	50.7 N	160.6 E	12	07	M 46	.5 NM	68	1008.0	0.0	4.0	12	29.5 07 12 19.5		
ATLANTIC JAN.																
RAINBOW HOPE	KNDB	2	54.3 N	38.8 W	18	27	50	2 NM	86	0996.4	1.0	7.0	7	32.5 27 12 39		
NEDLLOYD HUDSON	WPWH	12	40.2 N	45.1 W	00	30	45	2 NM	63	1001.5	5.8	13.2	5	16.5 29 8 32.5		
NEDLLOYD HUDSON	WPWH	12	40.4 N	42.8 W	06	29	56			1001.0	6.0	15.1	5	18 29 9 34.5		
NEDLLOYD HUDSON	WPWH	12	40.5 N	40.9 W	12	29	58	2 NM	90	1001.5	10.0	15.8	6	23 29 9 42.5		
NEDLLOYD HUDSON	WPWH	12	40.8 N	38.8 W	18	29	58	2 NM	81	1001.5	13.0	15.8	6	23 29 9 44		
CGM ILE DE FRANCE	KRPB	13	43.7 N	29.6 W	00	26	M 45	5 NM		0998.5	12.2	13.4	6	14.5 20 10 31		
NEDLLOYD HUDSON	WPWH	13	41.1 N	36.8 W	00	29	45	5 NM	01	1006.5	12.8	15.7	6	23 29 9 41		
NEDLLOYD HOLLAND	KRHX	19	34.2 N	64.7 W	12	30	M 47	10 NM	02	1014.0	16.7	18.0	8	19.5 30 10 29.5		
MARIT MAERSK	OZFC2	26	50.5 N	25.0 W	18	18	M 57	2 NM	41	1003.5	12.0	11.7	XX	32.5 19 XX 32.5		
PACIFIC FEB.																
SEALAND PATRIOT	KHRF	6	39.5 N	175.7 E	06	24	M 45	.5 NM	52	0968.5	10.0	4.4	6	10 25 17 29.5		
SEALAND PATRIOT	KHRF	6	39.5 N	178.1 E	12	25	M 48	1 NM	13	0970.0	12.0		8	29.5		
SEALAND PATRIOT	KHRF	6	39.7 N	179.0 W	18	24	M 53	5 NM	40	0969.8	11.0	6	8	24 19 37.5		
PETROBULK PROGRESS	C6JK6	10	26.4 N	170.2 E	00	27	M 52	2 NM	81	1003.0	71.8		14	28 27 16 32.5		
KEYSTONE CANYON	KSFK	10	52.9 N	135.7 W	12	14	M 53	2 NM	20	0992.5	10.0	6.7	8	29.5 14 15 32.5		
PETROBULK PROGRESS	C6JK6	10	26.3 N	168.7 E	18	30	M 45	2 NM	15	1007.5	16.0		8	16.5 28 14 29.5		
PRESIDENT JACKSON	WRYC	16	40.5 N	143.8 E	18	36	M 62	50 YD	84	0982.5	2.0	5.8	10	21 36 16 29.5		
MORELOS	XCMG	18	47.5 N	153.7 E	06	35	M 46	.5 NM	70	0974.5	2.8	2.5	12	28 35 14 32.5		
MORELOS	XCMG	18	46.2 N	152.8 E	12	32	M 47	.5 NM	71	0983.	2.2	2.0	12	28 35 15 34.5		
NATIONAL DIGNITY	DZRG	22	53.3 N	173.2 E	12	07	M 45	1 NM		0995.5	3.0	2.0	10	32.5 07 12 42.5		
ETERNITY	9VOF	23	34.7 N	179.0 E	18	30	M 50	10 NM	15	1005.0	13.5		10	29.5 30 10 13		
JAPAN ALLIANCE	7KBW	26	37.2 N	174.4 E	06	29	M 53	2 NM	10	0998.0	8.5	14.0	9	29.5 29 9 29.5		
NEPTUNE AMBER	S6CY	26	36.5 N	174.1 W	12	26	M 48			0990.0	13.5			26 14 29.5		
NEPTUNE AMBER	S6CY	26	36.5 N	170.0 W	21	28	M 55			0989.5	11.0		15	29.5 28 18 39		
NEPTUNE AMBER	S6CY	27	36.5 N	168.6 W	00	28	M 58			0992.5	11.0		15	29.5 28 18 39		
ATLANTIC FEB.																
SEALAND PERFORMANCE	KRPD	14	33.6 N	75.5 W	06	21	M 52	1 NM	64	0998.3	18.5	22.2	7	29.5 22 12 29.5		
EXPORT PATRIOT	WCJY	14	37.8 N	65.4 W	18	22	45	2 NM	25	0998.0	18.0	20.0	10	32.5 21 9 36		
PACIFIC MAR.																
LINDOE MAERSK	OWEQ2	5	39.1 N	178.0 E	00	31	50	2 NM	25	1005.2	9.0		10	29.5		
OLGA TOPIC	A8EE	13	53.8 N	175.3 W	00	25	60	.5 NM	93	1001.0	6.0	3.0	10	42.5		

VESSEL	CALL	POSITION		WIND		VSBY		PRES WX. code	PRESS- URE hPa	TEMP deg C.		SEA PD. sec	WAVES HGT. ft.		DIR PD. sec	WAVES HGT. ft.	
		DATE	LAT. deg.	LONG. deg.	TIME GMT	DIR. 10 deg.	SPEED kn.			Air	Sea						
NATIONAL HONOR	DZDI	13	54.0 N	169.0 W	00	24	M 45	5 NM	02	1002.0	2.0	6.0	6	28	24	7	31
OLGA TOPIC	A8EE	13	53.6 N	179.4 W	18	28	45	2 NM	84	0999.0	3.0	2.0	8	32.5			
NATIONAL HONOR	DZDI	13	52.5 N	173.3 W	18	25	M 59	1 NM	60	0998.7	2.0	6.0	10	32.5	25	12	39
OLGA TOPIC	A8EE	14	53.5 N	179.4 E	00	28	58	2 NM	84	0999.0	3.0	2.0	6	29.5			
NATIONAL HONOR	DZDI	14	52.5 N	174.6 W	00	25	M 57	1 NM	52	0998.7	2.0	5.0	10	32.5	2	12	39
HOEGH MIRANDA	C6IM7	14	54.6 N	167.7 W	06	23	M 51	1 NM		0991.0		4.8	XX	32.5	23	XX	32.5
HOEGH MIRANDA	C6IM7	14	54.6 N	168.0 W	12	24	M 49	2 NM		0996.0	2.0	XX	29.5	24		XX	29.5
OLGA TOPIC	A8EE	15	52.6 N	169.0 E	12	16	56	200 YD	85	0998.0	4.0	3.0	10	29.5			
OLGA TOPIC	A8EE	15	52.8 N	167.2 E	18	09	60	200 YD	85	0995.3	1.0	3.0	10	39			
NATIONAL HONOR	DZDI	16	52.3 N	177.4 E	12	23	M 49	1 NM	68	0999.5	2.0	5.0	8	29.5	23	10	36
PRINCE OF TOKYO 2	3EUU6	17	47.1 N	177.7 W	00	24	M 51	5 NM	03	1014.0	3.0	0.0	18	29.5	24	20	32.5
MARIT MAERSK	OZFC2	17	40.6 N	152.6 E	00	14	M 53	1 NM	62	1003.0	9.8	9.0	6	29.5			
MARIT MAERSK	OZFC2	17	41.4 N	154.8 E	06	15	M 72	1 NM	62	0992.0	8.0	7.7	9	32.5			
ATLANTIC MAR.																	
PVT HARRY FISHER	WMFW	16	34.5 N	58.0 W	15	28	M 60	5 NM	02	1000.0	17.8	18.0	4	13	28	9	32.5
PVT HARRY FISHER	WMFW	16	34.4 N	58.5 W	18	27	M 78	5 NM	03	1001.9	16.7		4	19.5	27	10	37.5
PVT HARRY FISHER	WMFW	17	34.5 N	60.3 W	06	29	M 70	10 NM	81	1009.0	13.3		4	10	33	12	32.5
PVT HARRY FISHER	WMFW	17	34.7 N	61.0 W	09	31	M 75	10 NM	81	1009.0	13.3		4	10	36	9	37.5

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U.S. VOS Weather Reports

January, February and March 1991

Ship Name	radio	mail	Ship Name	radio	mail	Ship Name	radio	mail
1ST LT ALEX BONNYMAN	20		CHEVRON LONDON	77		EVER GOODS	7	65
1ST LT JACK LUMMIS	22	3	CHEVRON METEOR	20	80	EVER GOVERN	32	
A. V. KASTNER	40		CHEVRON MISSISSIPPI	11	71	EVER GRAND	10	
ACADIA FOREST	124	81	CHEVRON NAGASAKI	3	106	EVER GROWTH	7	
ACE ACCORD	33	13	CHEVRON OREGON	79	109	EVER GUARD	30	44
ACONCAGUA		7	CHEVRON PACIFIC	47	103	EVER GUIDE	5	12
ACONCAGVD	8	47	CHEVRON SKY		202	EVER LAUREL	29	17
ACT 10	164		CHEVRON STAR		169	EVER LEVEL	23	23
ACT 11	13		CHICKASAW	13		EVER LINKING	19	6
ACT 111	235		CHINA CONTAINER	170	144	EVER LIVING	7	
ACT 12	140		CHIUQUITA BOCAS	134		EVER LOADING	4	
ACT 5	160		CHOAPA	52	16	EVER LYRIC	27	27
ACT 6	226		CITADEL HILL	22		EVER VITAL	7	65
ACT 7	215		CLARENCE	146		EXPORT FREEDOM	38	21
ACT I	182		CLEMENT	57		EXPORT PATRIOT	45	89
ACT IV	220		CLEMENTINA	16		EXXON BATON ROUGE	19	14
ADABELLE LYKES	72	107	CLEVELAND	27	48	EXXON CHARLESTON	1	
ADDIRIYAH	79	67	COASTAL CORPUS CHRISTI	3		EXXON LONG BEACH	13	25
ADMIRALTY BAY	30	79	COLIMA	23	104	EXXON MEDITERRANEAN		2
ADRIAN MAERSK	16	25	COLUMBINE	23	44	EXXON NEW ORLEANS	13	9
ADVANTAGE	1		COLUMBUS AMERICA	423		EXXON PHILADELPHIA	41	
AIDE	5		COLUMBUS AUSTRALIA	85		EXXON WILMINGTON	4	4
AINO	85	119	COLUMBUS CANADA	251		FAIRLIFT	98	
AL AHMADIAH	24	33	COLUMBUS LOUISIANA	145		FAIRMIND	1	
ALASKA MARU	47		COLUMBUS NEW ZEALAND	92		FALCON LEADER	22	
ALASKA RAINBOW	49	71	COLUMBUS OHIO	9		FALSTAFF	2	
ALBERT MAERSK	28	70	COLUMBUS OLIVOS	61		FALSTRIA	23	
ALDEN W. CLAUSEN	12	36	COLUMBUS ONTARIO	82		FARNELLA	277	
ALEMANIA EXPRESS	66		COLUMBUS QUEENSLAND	55		FAUST	58	29
ALISON LYKES	14		COLUMBUS VICTORIA	213		FERNCROFT	131	209
ALLIGATOR EXCELLENCE	70		COLUMBUS VIRGINIA	174		FESTIVALE	41	62
ALLIGATOR FORTUNE	30	4	COLUMBUS WELLINGTON	188		FETISH	133	62
ALLIGATOR HOPE	56	120	COMPANION EXPRESS	45		FLORIDA RAINBOW	68	195
ALLIGATOR JOY	55	161	CONCERT EXPRESS	66		FORTALEZA	105	204
ALLIGATOR LIBERTY	44		CONSENSUS SEA	26	13	FRANCES HAMMER	7	
ALLIGATOR PRIDE	26	94	CONTINENTAL WING	71	84	FRANCES L.	56	53
ALLIGATOR TRIUMPH	62		CONTINENTAL HIGHWAY	7		FRANCIS SINCERE NO. 6	52	
ALMERIA LYKES	34	74	CONTSHIP AUSTRALIA	15		FUJI	81	178
ALPHA HELIX	56	59	CONTSHIP SPAIN	25	34	GALVESTON BAY	55	172
ALTAMONTE	25	12	CORAH ANN	35	33	GATEWAY EAST	4	17
AMBASSADOR	8		CORMORANT ARROW	27		GEMINI	46	59
AMBASSADOR BRIDGE	71	19	CORNUCOPIA	20	7	GENEVIEVE LYKES	32	22
AMERICA EXPRESS	41		CORONADO	16		GEORGE A. STINSON	5	5
AMERICAN CONDOR	37		CORWITH CRAMER	80		GEORGE WASHINGTON BRID	169	
AMERICAN CORMORANT	9		COURIER	4	56	GEORGIA	4	114
AMERICAN EAGLE	5	1	CPL. LOUIS J. HAUGE JR	15	25	GERMAN SENATOR	76	
AMERICAN FALCON	42		CRISTOFORO COLOMBO	26	81	GERONIMO	6	4
AMERICAN KESTREL	10		CYPRESS PASS	22		GLACIER BAY	40	90
AMERICAN TRADER	48	105	D. L. BOWER		140	GLOBAL FAME	42	
AMERICANA	46	53	DAVID PACKARD		95	GLORIOUS SPICA	29	
AMERIGO VESPUCCI	25	41	DEL MONTE	7		GOLDEN BEAR	213	46
CAPE JUBY	85	167	DELAWARE TRADER	41	132	GOLDEN ENDEAVOR		3
CAPE LAMBERT	14		DEPPE AMERICA	88		GOLDEN GATE	24	23
CAPE LOBOS	5	114	DILIGENCE TRADER	1		GOLDEN GATE BRIDGE	232	71
CAPE MENDOCINO	14	30	DOLE ECUADOR	13	166	GOLDEN TOPAZ	11	27
CAPE MOHICAN	9		DON JORGE	4		GRAIGLAS	172	
CAPE NOME	2		DONALD		245	GREAT LAMB	198	215
CARIBAN	68		DUSSELDORF EXPRESS	85		GREAT RIVER	42	145
CARIBE 1	2	55	EASTERN GLORY	21	56	GREEN BAY	44	163
CARLA A. HILLS		52	EASTERN VENTURE	41	84	GREEN ELLIOTT		40
CARMAN	2		EDEN	22	48	GREEN ENGELLES	8	
CARMEL	45	90	EDGAR B. SPEER	14	22	GREEN HARBOUR	25	9
CAROLINA	29	74	EDWARD L. RYERSON	1		GREEN ISLAND	2	
CARTAGENA	112		EDWIN H. GOTT	36	34	GREEN KORE	83	
CASON J. CALLAWAY	42	46	EDYTH L.	46	55	GREEN LAKE	12	
CATTLEA ACE		38	ELBE MARU	53		GREEN MAYA	55	98
CENTURY HIGHWAY #2	230	112	ELIZABETH LYKES	42	86	GREEN RIDGE	6	
CENTURY HIGHWAY NO. 5	279	92	EMERALD SEA	150	60	GREEN SAIKAI	6	47
CGM ILE DE FRANCE	77	77	ENSOR	21	12	GREEN SUMA	25	148
CGM LORRAINE	37		EQUALITY STATE	28	47	GREEN VALLEY	38	85
CGM PROVENCE	129		ESSO PUERTO RICO	19	48	GREEN WAVE	25	31
CHABLIS	74	141	ETERNITY	16	150	GUANAJUATO	78	171
CHACO	7		EVER GAINING	16		GUAYAMA	24	49
CHALLENGER	79		EVER GALLANT	11	14	GULF BANKER	4	74
CHARLES E. WILSON	8	8	EVER GARLAND	2	29	GULF SENTRY	12	13
CHARLOTTE LYKES	62	66	EVER GENERAL	6	17	GULF SPEED	44	
CHELSEA	14		EVER GENIUS	4		GULF SPIRIT	32	
CHEMICAL PIONEER	41	96	EVER GENTLE	19	18	GULF TRADER	8	
CHERRY VALLEY	2		EVER GENTRY	2	23	GYPSON BARON	104	
CHESAPEAKE TRADER	42	132	EVER GIANT	4		GYPSON KING	89	
CHEVRON ANTHEM	15	55	EVER GIFTED	10		HAKONE MARU	91	
CHEVRON ARIZONA	13	16	EVER GIVEN	12		HANEI SKY	50	55
CHEVRON BURNABY	30	14	EVER GLAMOUR	8	5	HANEI SUN	49	64
CHEVRON CALIFORNIA	114	129	EVER GLOBE	10	7	HANJIN BUSAN	35	1
CHEVRON COLORADO	54	89	EVER GLORY	4		HANJIN CHEJU	31	19
CHEVRON HORIZON		18	EVER GLOWING	13		HANJIN CHUNGKJU	2	
			EVER GOING	30		HANJIN HONG KONG	25	29

Ship Name	radio	mail	Ship Name	radio	mail	Ship Name	radio	mail
HANJIN KEELUNG	10	16	KENTUCKY HIGHWAY	26		MING MOON	15	
HANJIN KOBE	25		KEYSTONE CANYON	42	59	MING OCEAN	7	
HANJIN KUNSAN	36	11	KEYSTONER	44	118	MING PLEASURE	31	
HANJIN KWANG YANG	29	28	KISO	107		MING PLENTY	12	41
HANJIN LE HAVRE	2		KOLN ATLANTIC	108		MING STAR	8	
HANJIN LONG BEACH	5		KOPER EXPRESS	44		MISSION BUENAVENTURA	30	63
HANJIN MASAN	11		KUROBE	81		MITLA	29	4
HANJIN NEW YORK	17		LAKE	6		MOANA PACIFIC	69	
HANJIN POKANG	26	32	LASH ATLANTICO	5		MOU PAMU	36	60
HANJIN SAVANNAH	17	13	LAURA MAERSK	39	97	MONA WAVE	125	110
HANJIN SEATTLE	3		LAWRENCE H. GIANELLA	2		MONTERREY	119	
HANJIN SEOUL	23	30	LESLIE LYKES	37		MORELLO	85	54
HANJIN TONGHAE	12		LETITIA LYKES	3	53	MORELOS	101	130
HANJIN YOKOHAMA	8	10	LEWIS WILSON FOY	12	12	MORMACSKY	19	20
HANNOVERLAND	85		LIBERTY STAR	118	205	MORMACSTAR	66	64
HANSA LUBECK	154		LIBERTY SUN	51	43	MORMACUS	22	29
HARMAC DAWN	3		LIBERTY WAVE	9	39	MSC CHIARA	49	44
HARRIET LANE		53	LILAS	38	371	MSC SABBINA	21	53
HAWAIIAN RAINBOW	32		LINDOE MAERSK	87	125	MV CAPE DIAMOND	9	76
HEIDELBERG EXPRESS	71		LIRCAY	48		MYRON C. TAYLOR	10	10
HENRY HUDSON BRIDGE	185		LANG AQUARIUS	45	102	NACIONAL SANTOS	1	
HERBERT C. JACKSON	6		LANG CAPRICORN	20		NANCY LYKES	58	56
HERMENIA	39	61	LANG LEO	76	51	NARA	70	131
HIBISCUS		75	LANG TAURUS	8	36	NATIONAL DIGNITY	24	164
HIRA II	81		LANG VIRGO	28	45	NATIONAL HONOR	41	201
HOEGH CAIRN	16	28	LONDON SENATOR	132		NATIONAL PRIDE	44	69
HOEGH CLIPPER	20		LOTUS ACE	78		NAVIOS UNIQUE	45	
HOEGH DENE	10		LOUIS MAERSK	36	64	NCC ARAR	3	
HOEGH DRAKE	3		LOUISE LYKES	34		NECHES	6	
HOEGH DUKE	24		LOUISIANA	5	31	NEDDLOYD BAHRAIN	156	
HOEGH DYNE	6	22	LOUISIANA BRIMSTONE	44	30	NEDDLOYD BALTIMORE	139	
HOEGH MASCOT	10	69	LT. ODYSSEY	16		NEDDLOYD BANGKOK		
HOEGH MIRANDA	22	53	LURLINE	40	175	NEDDLOYD BARCELONA	127	
HOLIDAY	30	38	LYRA	16		NEDDLOYD HOLLAND	45	158
HOLLANDIC	8		M. P. GRACE	24		NEDDLOYD HUDSON	66	146
HONOLULU	100		MAASSLOT	161		NEDDLOYD KEMBLA	105	
HOWELL LYKES	30	96	MACKINAC BRIDGE	212	54	NEDDLOYD KINGSTON	56	
HUAL ANGELITA	29	19	MADAME BUTTERFLY	2		NEDDLOYD KYOTO	12	
HUMACAO	42	155	MAERSK COMMANDER	76		NEDDLOYD MANILA	108	
HYUNDAI #201	34		MAERSK CONSTELLATION	37	109	NEDDLOYD ROTTERDAM	96	
HYUNDAI CHALLENGER	24		MAERSK PINE	152	96	NEDDLOYD ROUEN	146	
HYUNDAI COMMANDER	25	9	MAERSK SUN	92	224	NEDDLOYD VAN CLOON	86	
HYUNDAI CONTINENTAL	37		MAERSK WAVE	1		NEPTUNE ACE	83	
HYUNDAI EXPLORER	21	19	MAERSK WIND	44	64	NEPTUNE AMBER	101	258
HYUNDAI INNOVATOR	12	25	MAGALLANES	8	21	NEPTUNE CORAL	33	
HYUNDAI NO 102	21		MAGIC	111	136	NEPTUNE CRYSTAL	63	104
HYUNDAI PIONEER	14		MAGLEY MAERSK	35	54	NEPTUNE DIAMOND	110	
INCOTRANS PACIFIC	37		MAGLEY MHERSK		54	NEPTUNE GARNET	50	
INDEPENDENT SPIRIT	97		MAINE	2		NEPTUNE JADE	72	
INDIAN OCEAN	7	23	MAJ STEPHEN W PLESS MP	54	98	NEPTUNE PEARL	55	35
INFANTA	117		MAJESTIC MAERSK	41	86	NEW DUQUESA		55
INGER	26	35	MAJURO	7		NEW HORIZON	98	126
ISLAND PRINCESS	56		MALORY LYKES	7	136	NEW NOBLE	2	
ITAFE	18		MANHATTAN BRIDGE	139		NEWARK BAY	52	122
ITB BALTIMORE	65	124	MANUKAI	50	168	NIPPOON HIGHWAY	7	5
ITB CHARLESTON	44	38	MANULANI	19	148	NOAA DAVID STARR JORDA		54
ITB NEW YORK	25	32	MARATHA MAJESTY	6		NOAA SHIP CHAPMAN	131	62
ITB PHILADELPHIA	117	51	MARCHEN MAERSK	33	88	NOAA SHIP DELAWARE II	374	
J.L. MAUTHE	1		MAREN MAERSK	31	29	NOAA SHIP DISCOVERER O	271	296
JACKSONVILLE	34	21	MARGARET LYKES	63	81	NOAA SHIP FERREL	7	
JALISCO	50		MARGRETHE MAERSK	47	24	NOAA SHIP M. BALDRIDGE	422	386
JAMES LYKES	21		MARIA TOPIC	16		NOAA SHIP MILLER FREEM	209	126
JAPAN ALLIANCE	115	115	MARIE MAERSK	20	95	NOAA SHIP MT MITCHELL	79	87
JAPAN APOLLO	80	87	MARIF	36	48	NOAA SHIP OREGON II	265	114
JAPAN CARRYALL	18		MARINE RELIANCE	17	1	NOAA SHIP RAINIER	38	
JAPAN RAINBOW #2	9		MARIT MAERSK	21	87	NOAA SHIP SURVEYOR	196	
JEAN LYKES	30	34	MARITIME FRIENDSHIP	1		NOAA SHIP T. CROMWELL	448	508
JO BIRK	111		MARJORIE LYKES	32	11	NOAA SHIP WHITING	36	
JO CLIPPER	69		MARLIN		236	NOBEL STAR	47	39
JO CYPRESS	147		MASON LYKES	58	62	NOSAC EXPLORER	31	
JO LONN	72		MATHILDE MAERSK	24	59	NOSAC EXPRESS	27	40
JO OAK	66		MATSONIA	80	189	NOSAC RANGER	50	41
JO ROGN	66		MAUI	63	203	NOSAC SUN	8	
JOHN A. MCCONE		133	MAURICE EWING	13	90	NOSAC TAI SHAN	26	43
JOHN G. MUNSON	30	31	MAYAGUEZ	41		NOSAC TAKARA	16	
JOHN LYKES	29		MEDALLION	64	32	NOSAC TAKAYAMA	92	
JOVIAN LILY	50	225	MEDUSA CHALLENGER	8	11	NOVA EUROPA	102	136
JOVIAN LUZON	108	139	MERCANDIAN CONTINENT	44		NUOVO SAN JUAN	36	105
JULIUS HAMMER	49	38	MERCANDIAN SUN II	95	85	NURNBERG ATLANTIC	153	
JUPITER	6	64	MERCURY ACE	78		OAXACA	96	
K. TOPIC	14		MERIDA	64	48	OCEAN ASPIRATION	19	34
KAIMOKU	62	172	MERKUR AMERICA	55		OCEAN BRIDGE	14	
KAINULA	33	144	MERKUR PORTUGAL	39		OCEAN CHEER	48	
KALIDAS	1		MESABI MINER	3		OCEAN COMMANDER #1	1	
KATHLEEN PEARCY	54	12	METTE MAERSK	70	129	OCEAN CONQUEROR	50	119
KAUAI	67	199	MICHIGAN HIGHWAY	28		OCEAN HIGHWAY	40	
KAYE E. BARKER	49	34	MICRONESIAN COMMERCE	32		OCEAN ISLAND	5	
KEBAN		15	MIDDLETOWN	6		OCEAN LILY	34	30
KEE LUNG	10	63	MINDORO SAMPAGUITA	11		OCEAN MASTER	12	
KEISHO MARU	44		MINERAL OSPREY	54	78	OCEAN SEL	3	68
KENAI	56	47	MINERVA	29		OCEAN SPIRIT	1	
KENNETH E. HILL	12	70	MING COMFORT	12		OLEANDER	129	9
KENNETH T. DERR		7	MING GALAXY	1		OLGA TOPIC	28	183
			MING LONGEVITY	10		OMI MISSOURI	43	34

Ship Name	radio	mail	Ship Name	radio	mail	Ship Name	radio	mail
OMI WABASH	53	47	PRESIDENT WASHINGTON	123		SEALAND QUALITY	64	121
OCL CHARGER	87		PRESQUE ISLE	7	15	SEALAND RELIANCE	30	35
OCL DOMINANCE	9		PRIDE	1	31	SEALAND SPIRIT	59	257
OCL EDUCATOR	55		PRIMOJE	3		SEALAND TACOMA	43	107
OCL EXECUTIVE	44	34	PRINCE OF TOKYO	106	219	SEALAND TRADER	44	
OCL FAIR	23	27	PRINCE OF TOKYO 2	107	227	SEALAND VALUE	69	158
OCL FAITH	58	18	PRINCE WILLIAM SOUND	38	36	SEALAND VOYAGER	119	124
OCL FORTUNE	42	27	PUERTO CORTES	24		SEANARD BAY	47	73
OCL FRIENDSHIP	34	28	PURITAN	25		SECO/SP 471	108	107
ORANGE BLOSSOM	130	172	PVT HARRY FISHER	27	152	SEKINOLE	58	123
ORCHID	48	166	QUALITY OF LIFE	44		SENATOR	53	
ORCHID #2	22	10	QUEEN ELIZABETH 2	51		SHELDON LYKES	88	206
OREGON RAINBOW II	66	55	RAINBOW BRIDGE	61	68	SHELLY BAY	54	127
ORIENTAL DIPLOMAT	43		RAINBOW HOPE	111	128	SHIN BEISHU MARU	65	
ORIENTAL EXPLORER	60	131	RALEIGH BAY	51	141	SHINKASHU MARU	57	
ORIENTAL FERM	36	7	RANA M	10		SHIRAOI MARU	124	35
ORIENTAL FREEDOM	93		RECIFE	82		SIERRA MADRE	11	
ORIENTAL PATRIOT	62		RED ARROW	34		SILVER CLIPPER	49	20
ORION HIGHWAY	63	251	RELIANCE TRADER	1		SILVER HILL	80	144
OVERSEAS ALICE	4		RESOLUTE	39	95	SITHEA	33	102
OVERSEAS BOSTON		112	RICHARD G MATTIESEN	3		SKANDERBORG	45	53
OVERSEAS CHICAGO	13		RIO FRIO	89		SKAUBORD	161	167
OVERSEAS JOYCE	67	87	RIO NEGRO II	28	19	SKAUGRAN	121	48
OVERSEAS JUNEAU		84	RISING STAR	28	120	SKEENA	93	
OVERSEAS MARILYN	30	58	ROBERT E. LEE	16		SKODSBORG	1	
OVERSEAS NEW ORLEANS	63	108	ROGER BLOUGH	15		SOARER CUPID	47	151
OVERSEAS NEW YORK	23		ROSEBANK	132		SOLAR WING	85	
OVERSEAS OHIO	10	25	ROSETTA	88	124	SOPHIA	82	52
OVERSEAS PHILADELPHIA	20	38	ROSINA TOPIC	19	63	SOPHIA	33	
OVERSEAS VIVIAN	8		ROTTERDAM	65		SOREN TOUBRO	4	
PACASIA	13		ROVER	20	108	SOUTHLAND STAR	132	
PACBARON	2		ROWANBANK	68		SPIRIT OF TEXAS	43	71
PACDUCHESS	37		ROYAL PRINCESS	99		SPRING BEAR	138	
PACDUKE	30	17	ROYAL VIKING SKY	3		SPRING BEE	36	
PACGLORY	23		RUBIN OCEAN	27	56	SPRING STORK	48	
PACIFIC EMERALD	23	94	RUTH LYKES	10		ST EMILION	35	69
PACIFIC PRINCESS	120		S.T. CRAPO	22	27	STAR CANADIAN	28	49
PACIFIC SENTRY	3	4	SALINAS	24	107	STAR EAGLE	51	66
PACKING	35	21	SAM HOUSTON	23	16	STAR EVVIVA	21	
PACMERCHANT	33	2	SAMU	22	129	STAR FLORIDA	110	
PACNOBLE	36	25	SAMUEL L. COBB	17	8	STAR FRASER	98	
PACOCAN	18		SAN LUIS	17		STAR FUJI	10	
PACPRINCE	15		SAN MARTIN	51		STAR GEIRANGER	12	7
PACPRINCESS	61		SAN MATEO VICTORY	24	66	STAR GRAN	64	37
PACQUEEN	15		SANKO PRELUDE	51	139	STAR GRINDANGER	17	
PACSTAR	27		SANSINENA II	56	131	STAR HONG KONG	75	
PACTRADER	4		SANTA ANA	8		STAR MERCHANT		146
PAGA	17		SANTA JUANA	82	35	STAR MERIT	20	
PAPAGO	117		SANTA MARTA	75		STAR MINERVA	48	60
PAPYRUS	25	85	SANMA MARU	38		STAR MUSKETEE	1	10
PATRIOT	21		SAFARI	7	13	STAR OF TEXAS	5	
PATRIOT STATE	8		SATURN DIAMOND	67		STAR WILMINGTON	14	
PAUL BUCK	2		SAUDI TABUK	7		STELLA LYKES	40	77
PAUL H. TOWNSEND	4		SAVANNAH	67		STENA TRAILER	90	
PECOS	29	36	SCAN	3		STEWART J. CORT	8	4
PEGGY DOW	158		SCARAB	90	100	STONEMALL JACKSON	1	
PELANDER	25	32	SEA BELLS	36	72	STUTTGART EXPRESS	144	
PENNSYLVANIA TRADER	22		SEA BREEZE II	8	15	SUE LYKES	24	43
PERMEKE	70		SEA COMMERCE	273		SUGAR ISLANDER	78	
PETER W. ANDERSON	13		SEA FAN	61	112	SUNBELT DIXIE	2	93
PETROBULK PROGRESS	80	139	SEA FORTUNE	19	162	SUNRISE RUBY	19	111
PFC JAMES ANDERSON JR	60	81	SEA FOX	56	27	SWAN CAPE	24	32
PFC WILLIAM B. BAUGH	1	68	SEA LIGHT	28	7	SWAN LAKE	73	156
PHAROS	76		SEA LION	286	157	SWIFTNES	26	
PHILIP R. CLARKE	7		SEA MERCHANT	352	132	TABASCO	68	81
PHILLIPS VENEZUELA		59	SEA TRADE	82		TAI CHUNG	9	40
PHOENIX DIAMOND	7		SEA WOLF	327	251	TAI CORN	15	34
PINE FOREST	20	37	SEALAND ACHIEVER	141		TAI SHING	11	16
POLAR ALASKA		175	SEALAND ANCHORAGE	63	163	TALISMAN	32	
POLYNESIA	167	290	SEALAND ATLANTIC	58	60	TAMPA	54	29
POMEROL	4	15	SEALAND CHALLENGER	47	29	TAMPA BAY	3	3
PONCE	8	19	SEALAND CONSUMER	31	49	TEXACO NEW YORK	18	11
POQUITA MAMI	68		SEALAND CRUSADER	95	53	TEXACO WESTCHESTER	46	22
POTOMAC TRADER	94	165	SEALAND DEFENDER	136	156	TEXAS TRADER	51	7
PRESIDENT ADAMS	98	143	SEALAND DEVELOPER	66	93	THOMAS WASHINGTON	90	115
PRESIDENT ARTHUR	23	35	SEALAND DISCOVERY	68	99	THOMPSON LYKES	13	
PRESIDENT BUCHANAN	31	113	SEALAND ENDURANCE	64	82	THOMPSON PASS		56
PRESIDENT EISENHOWER	154	225	SEALAND ENTERPRISE	138	156	TILLIE LYKES	41	84
PRESIDENT F. ROOSEVELT	41	178	SEALAND EXPEDITION	15	71	TOMA	27	2
PRESIDENT GRANT	65	167	SEALAND EXPLORER	72	117	TOHZAN	11	16
PRESIDENT HARDING	45		SEALAND EXPRESS	73	93	TOLUCA	116	102
PRESIDENT HARRISON	129		SEALAND FREEDOM	61	108	TONCI TOPIC	4	32
PRESIDENT HOOVER	95	154	SEALAND HAWAII	64	118	TONSINA	40	17
PRESIDENT JACKSON	149	151	SEALAND INDEPENDENCE	34	91	TORRENS	11	33
PRESIDENT JEFFERSON	28	37	SEALAND INNOVATOR	103	166	TRANSWORLD BRIDGE	58	15
PRESIDENT JOHNSON	55	67	SEALAND INTEGRITY	51	64	TRIGGER	98	144
PRESIDENT KENNEDY	87	125	SEALAND KOTIAK	39	124	TROPIC SUN	3	5
PRESIDENT LINCOLN	125	145	SEALAND LIBERATOR	76	111	TROPICAL BEAUTY	3	82
PRESIDENT MADISON	42	123	SEALAND MARINER	63	157	TROPICALE	19	28
PRESIDENT MONROE	100		SEALAND NAVIGATOR	47	89	TULSIDAS	15	
PRESIDENT PIERCE	3	6	SEALAND PACIFIC	206	175	TUMILCO	194	
PRESIDENT POLK	141	205	SEALAND PATRIOT	60	88	TYSON LYKES	47	85
PRESIDENT TRUMAN	83	110	SEALAND PERFORMANCE	80	160	ULTRAMAR	14	2
PRESIDENT TYLER	82	172	SEALAND PRODUCER	61	233	ULTRASEA	7	79

Ship Name	radio	mail	Ship Name	radio	mail	Ship Name	radio	mail
UNAMONTE	14		USNS DENEbola	47	69	WILFRED SYKES	34	
URTE	221	184	USNS GUS W. DARNELL	68	48	WILLIAM E. MUSSMAN	24	120
USCGC ACACIA (WLB406)	13	31	USNS HENRY J. KAISER		12	WILLIAM J. DELANCEY	14	21
USCGC ACTIVE WMEC 618	30		USNS JOHN LENTHAL		43	WINDWARD SENTRY	15	56
USCGC ALERT (WMEC 630)	1		USNS JOSHUA HUMPREYS		120	WINTER MOON	103	
USCGC BASSWOOD (WLB 38)	51		USNS KAWISHWI	11		WORLD WING #2	51	24
USCGC BEAR (WMEC 901)	1		USNS LEROY GRUMMAN		33	YACU WAYO	17	11
USCGC BISCAYNE BAY	1		USNS LYNCH T-AGOR 7		15	YAMATAKA MARU	63	
USCGC BOUTWELL WHEC 71	12		USNS MERCURY	53		YANKEE CLIPPER	104	
USCGC BRAMBLE (WLB 392)	7		USNS METEOR	37	23	YOKOHAMA	6	
USCGC BUTTONWOOD WLB 3	1		USNS MISSISSINEMA		112	YOUNG SKIPPER	29	
USCGC CAMPBELL	26		USNS MOHAWK (T-ATF 170)	48		YOUNG SOLDIER	40	
USCGC CHILULA (WMEC 15)	91		USNS NARRAGANSETT	25	48	YOUNG SPORTSMAN	2	
USCGC CITRUS (WMEC 300)	4		USNS NAVAJO	51	125	YOUNG SPROUT	67	89
USCGC COURAGEOUS	17		USNS PAWCATUCK TAO-108		144	ZEELANDIA	111	
USCGC DEFENDABLE		16	USNS PECOS	5		ZIM AMERICA	45	
USCGC DURABLE (WMEC 62)	17		USNS POLLUX	5	7	ZIM CALIFORNIA	48	
USCGC ESCAPE (WMEC 6)	133		USNS POTPMAC	31		ZIM CANADA	71	
USCGC FIREBUSH WLB 393	4		USNS POMAHATAN TATF 166	44	51	ZIM HAIFA	58	
USCGC FORWARD	21	156	USNS REGULUS	34		ZIM HONGKONG	38	
USCGC HAMILTON WHEC 71	4		USNS RELENTLESS	1		ZIM HOUSTON	36	
USCGC HARRIET LANE	3		USNS RICEL (T-AF 58)		55	ZIM IBERIA	31	
USCGC IRONWOOD (WLB 29)	108	144	USNS SATURN T-AFS-10		92	ZIM KEELUNG	36	
USCGC LEGARE	11		USNS SEALIFT ANTARCTIC	47	10	ZIM KINGSTON III	355	
USCGC MACKINAW	19	79	USNS SEALIFT ARABIAN S	2		ZIM MARSEILLES	51	
USCGC MALLOW (WLB 396)	3		USNS SEALIFT ARCTIC	46	50	ZIM MIAMI	31	
USCGC MUNRO	106		USNS SEALIFT ATLANTIC	179	194	ZIM NEW YORK	12	
USCGC NEAH BAY	2		USNS SEALIFT CARIBBEAN	22	90	ZIM SAVANNAH	24	
USCGC NORTHLAND WMEC 9	29	31	USNS SEALIFT CHINA SEA	6	68	ZIM TOKYO	69	
USCGC PLANETREE	7		USNS SEALIFT IND'N OCE	30	40	ZOELLA LYKES	3	62
USCGC POLAR SEA WAGB 1	347	168	USNS SEALIFT MEDITERRA	33	83			
USCGC RELIANCE WMEC 61	30		USNS SEALIFT PACIFIC	15				
USCGC SEDGE (WLB 402)	32		USNS SILAS BENT T-AGS	6				
USCGC STEADFAST WMEC 6	9		USNS SIRIUS (T-AFS 8)		4			
USCGC STORIS (WMEC 38)	37		USNS SPICA (T-AFS 9)		10			
USCGC SWEETBRIER WLB 4	32		USNS VANGUARD TAG 194	85				
USCGC TAHOMA	52		VALLEY FORGE		66			
USCGC TAMAROA (WMEC 16)	33		VAN TRADER	34	102			
USCGC THETIS	1		VIKING ACE	41	61			
USCGC VALIANT (WMEC 62)	23	33	VINE	154				
USCGC VIGILANT WMEC 61	2		VISHVA SIDDHI	1				
USCGC VIGOROUS WMEC 62	27		VISHVA VIKRAM	5				
USCGC YOCONA (WMEC 168)	33	45	WASHINGTON RAINBOW #2	66	167			
USNA SIOUX	8		WESTWARD	17				
USNS ALTAIR			WESTWARD VENTURE		143			
USNS APACHE (T-ATF 172)	41	36	WESTWOOD ANETTE	34	98			
USNS BARTLETT (T-AGOR 1)	1	61	WESTWOOD BELINDA	14	26			
USNS BELATRIX	13	4	WESTWOOD CLEO	143	144			
USNS CAPELLA	41	84	WESTWOOD JAGO	94	46			
USNS COMET	14	10	WESTWOOD MARIANNE	24	107			
USNS DE STEIGUER	68	133	WHITE ROSE	28	46			

SUMMARY: GRAND TOTAL VIA RADIO 50172

GRAND TOTAL VIA MAIL 44903

TOTAL UNIQUE OBS 77481

TOTAL DUPLICATES 17594 (22.7%)

UNIQUE RADIO OBS. 32578 (42.0%)

UNIQUE MAIL OBS. 27309 (35.2%)

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The University of Michigan
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Ann Arbor, MI 48109

January, February and March 1991

Summer 1991 75

NDBC Station Data Summary

January, February and March 1991

Wave observations are taken each hour during a 20-minute averaging period, with a sample taken every 0.67 seconds. The significant wave height is defined as the average height of the highest one-third of the waves during the average period each hour. The maximum significant wave height is the highest of those values for that month. At most stations, air temperature, water temperature, wind speed and direction are sampled once per second during an 8.0-minute averaging period each hour (moored buoys) and a 2.0-minute averaging period for fixed stations (C-MAN). Contact NDBC Data Systems Division, Bldg 1100, SSC, Mississippi 39529 or phone (601) 688-2838 for more details.

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
41001	34.9N	073.0W	0740	16.0	20.4	2.4	5.4	09/06	16.5	NW	50.7	20/15	1019.1
41002	32.3N	075.2W	0744	19.9	23.4	2.1	5.3	20/16	13.9	W	35.5	20/09	1019.3
41006	29.3N	077.4W	0744	21.6	23.7	1.8	3.3	20/08	12.0	S	31.1	20/09	1020.5
41008	30.7N	081.1W	0743	14.2	15.8	1.1	2.7	11/10	10.7	N	24.3	24/22	1020.8
41009	28.5N	080.2W	1486	20.7	22.8	1.2	2.8	11/09	11.1	S	30.9	20/07	1019.8
41010	28.9N	078.5W	1485	21.7	23.8	1.6	3.5	20/07	11.9	S	33.8	20/09	1020.1
42001	25.9N	089.7W	0743	21.3	22.9	1.3	3.0	31/22	13.1	E	23.5	31/14	1018.3
42002	25.9N	093.6W	0741	21.0	22.8	1.4	3.2	31/13	13.8	NE	27.6	15/07	1017.3
42003	25.9N	085.9W	0742	22.7	24.6	1.2	2.7	16/03	14.0	E	24.7	30/16	1019.3
42007	30.1N	088.8W	0744		15.8				13.2	NE	31.9	19/05	1020.1
42019	27.9N	095.0W	0744	17.4	21.3	1.5	4.5	15/05	13.9	NE	28.2	15/01	1018.7
42020	27.0N	096.5W	0743	17.8	21.1	1.5	3.0	21/07	13.4	N	25.1	31/01	1018.6
44001	38.4N	073.7W	0742	7.4	11.8	1.7	5.4	12/11	14.9	NW	31.1	09/08	1020.4
44004	38.5N	070.7W	0742	9.5	15.4	2.2	6.4	19/07	15.8	NW	36.5	12/14	1019.6
44005	42.7N	068.6W	0743	0.9	5.9	1.9	5.5	12/18	15.6	W	31.7	12/13	1018.6
44007	43.5N	070.1W	0744	-2.5	4.8	0.9	5.0	12/22	14.5	SW	32.3	19/04	1019.5
44008	40.5N	069.4W	0743	4.0	7.4	1.8	5.1	12/16	15.8	NW	37.5	19/08	1019.7
44009	38.5N	074.7W	0740	5.4	8.2	1.2	4.4	09/06					1020.7
44011	41.1N	066.6W	0683	3.5	5.1	1.7	5.7	17/11	13.3	NW	36.3	19/10	1018.2
44012	38.8N	074.6W	0743	4.7	7.2	1.1	3.8	12/00	15.4	NW	34.8	31/18	1020.6
44013	42.4N	070.8W	0742	-0.5	4.7	0.6	3.6	12/21	14.7	SW	36.5	31/22	1020.0
44014	36.6N	074.8W	0742	9.0	11.1	1.6	5.2	09/06	13.6	N	29.5	07/22	1020.4
44015	37.1N	073.6W	0631	11.5	16.8	1.8	5.9	12/08					1021.4
44023	37.5N	074.4W	0415	7.9	11.0	1.4	4.0	16/17	13.6	SW	27.0	21/15	1016.6
45002	45.3N	086.4W	0743	-5.7	3.9	1.2	5.6	23/04					1018.7
45004	47.5N	086.5W	0741	-2.7	3.0	1.5	4.7	23/00					1018.6
46001	56.3N	148.3W	0741	2.7	3.9	3.4	11.0	19/15	16.0	E	37.9	17/09	1012.3
46002	42.5N	130.4W	0743	10.5	11.2	2.8	7.3	13/19	12.5	SW	29.3	11/10	1021.5
46003	51.9N	155.9W	0743	4.1	4.5	3.9	16.9	19/04	17.6	E	43.7	19/00	1004.3
46005	46.1N	131.0W	0572	8.5	8.8	3.1	7.4	13/19	12.3	S	36.5	11/11	1019.5
46006	40.8N	137.7W	0272	13.0	12.9	2.9	7.2	11/04	17.1	SW	29.7	11/00	1012.6
46010	46.2N	124.2W	0743	6.6	7.1	2.2	5.2	12/09	13.4	E	34.6	11/16	1021.4
46011	34.9N	120.9W	0741	12.2	13.1	1.8	4.9	14/17	8.1	NW	23.5	16/04	1020.7
46012	37.4N	122.7W	0741	11.0	11.8	1.8	4.3	14/13	8.1	NW	25.2	16/03	1021.2
46013	38.2N	123.3W	0740	10.2	10.5	1.9	4.8	14/14	8.8	NW	26.1	16/01	1021.5
46014	39.2N	124.0W	0742	9.7	10.7	2.1	4.4	14/15	9.1	NW	27.6	28/23	1021.4
46023	34.3N	120.7W	0742	12.3	13.3	2.0	4.8	14/18	11.1	NW	28.3	16/04	1019.3
46025	33.8N	119.1W	0743	14.1	14.8	1.0	2.7	16/03	6.9	NW	27.4	16/16	1019.5
46026	37.8N	122.7W	0741	10.0	10.4	1.5	4.8	14/10	9.2	E	26.4	16/04	1021.4
46027	41.8N	124.4W	0736	8.5	8.8	2.1	5.4	14/07	10.7	N	30.3	24/02	1021.5
46028	35.8N	121.9W	0743	11.6		2.0	5.0	14/15	9.1	NW	29.9	16/03	1021.1
46035	57.0N	177.7W	0743	-1.9	2.1	3.9	10.8	24/06	22.1	NE	41.2	23/21	1008.5
46042	36.8N	122.4W	0744	11.0	12.1	2.0	4.6	14/16	8.3	N	24.9	16/05	1021.3
46045	33.8N	118.5W	0026	14.0	14.5	0.4	0.5	31/02	6.0	W	9.5	31/21	1022.8
51001	23.4N	162.3W	0742	22.4	23.9	2.8	7.3	28/04	10.7	E	30.7	28/00	1015.9
51002	17.2N	157.8W	0382	24.2		2.3	4.6	29/08	11.6	NE	20.8	17/12	1013.6
51003	19.2N	160.8W	0742	24.0	25.1	2.4	4.7	28/18	9.8	W	22.4	28/00	1014.5
ALSN6	40.5N	073.8W	0730	2.1	6.2	0.9	4.1	12/05	15.8	NW	38.9	31/17	1021.1
BURL1	28.9N	089.4W	0743	12.3					15.1	NE	31.8	30/01	1018.9
BUSL1	27.9N	090.9W	0467	17.8	22.7				16.4	N	33.6	18/16	1018.0
BUZM3	41.4N	071.0W	0743	1.5		1.2	2.8	12/15	16.2	W	36.9	19/04	1021.1
CAR03	43.3N	124.4W	0744	7.6					11.8	S	34.9	12/00	1022.1
CHLV2	36.9N	075.7W	0741	7.1	8.5	1.1	3.7	07/19	15.7	N	35.3	09/03	1021.2
CLKN7	34.6N	076.5W	0744	9.9					11.2	N	24.0	01/03	1021.5
CSBF1	29.7N	085.4W	0743	13.7					6.3	NE	31.6	15/21	1020.6
DBLN6	42.5N	079.4W	0737	-2.5					14.8	SW	46.1	18/19	1019.7
DESN1	47.7N	124.5W	0743	5.6					11.3	SE	41.7	11/14	1021.3
DISN3	47.1N	090.7W	0741	-9.5					14.4	W	33.9	18/06	1019.0
DPIA1	30.3N	088.1W	0744	12.1	13.6				12.1	N	31.4	19/10	1021.1
DSLN7	35.2N	075.3W	0739	12.1	17.6	1.7	4.4	08/14	17.9	N	45.3	12/03	1020.8

BOUY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
ENIP2	11.4N	162.4E	0742	26.9					16.7	E	26.2	18/11	1009.7
FBIS1	32.7N	079.9W	0744	10.6					8.4	NE	23.9	01/05	1021.7
FFIA2	57.3N	133.6W	0743	0.1					13.8	N	31.4	25/05	1019.1
PPSN7	33.5N	077.6W	0744	13.7					16.3	N	38.6	11/19	1021.3
GBCL1	27.8N	093.1W	0743	17.6	22.1	0.9	2.3	15/09	15.7	NE	35.4	15/04	1019.0
GDIL1	29.3N	090.0W	0744	12.8	14.7				12.1	NE	28.6	19/05	1019.8
GLLNG	43.9N	076.5W	0739	-3.7					16.0	W	41.2	18/19	1019.6
IOSN3	43.0N	070.6W	0708	-1.7					15.8	W	39.9	31/18	1020.2
KOSP2	5.4N	163.0E	0740	27.5					10.1	NE	23.4	07/15	1008.2
LKWF1	26.6N	080.0W	0739	22.0	23.9				11.1	E	27.8	10/18	1019.8
MDRM1	44.0N	068.1W	0742	-2.4					18.0	NW	40.0	19/03	1018.1
MISM1	43.8N	068.9W	0492	-1.8					18.9	W	45.4	19/07	1013.0
MLIP2	6.1N	172.6E	0742	27.6					10.9	NW	26.9	20/20	1007.7
MLRF1	25.0N	080.4W	0737	23.7	24.9				13.1	SE	26.0	16/10	1019.2
MPCL1	29.4N	088.6W	0733	15.3	18.1	0.9	2.2	19/06	14.2	NE	32.6	15/15	1019.5
NWPO3	44.6N	124.1W	0744	6.5					10.3	E	35.0	11/22	1021.3
PAGP2	18.1N	145.8E	0743	24.7					7.2	NE	16.6	26/23	
PILM4	48.2N	088.4W	0737	-11.2					16.5	NW	36.1	18/05	1017.8
PTAC1	39.0N	123.7W	0743	8.6					7.1	N	24.1	30/21	1021.8
PTAT2	27.8N	097.1W	0744	11.8	12.8				11.3	N	27.2	21/00	1019.2
PTGC1	34.6N	120.7W	0742	12.1					10.3	N	34.3	16/03	1020.0
ROAM4	47.9N	089.3W	0640	-10.5	4.8				15.5	W	37.1	22/18	1019.8
SANF1	24.5N	081.9W	0468	23.1					11.6	SE	21.3	16/08	1017.9
SAUF1	29.9N	081.3W	0740	15.0	15.9				10.5	N	30.3	24/22	1020.4
SBI01	41.6N	082.8W	0739	-2.8					14.1	SW	35.6	24/00	1020.6
SGNW3	43.8N	087.7W	0739	-7.5					13.3	W	33.1	22/22	1020.1
SISW1	48.3N	122.9W	0743	4.7					7.8	SE	34.0	11/15	1022.6
SMKF1	24.6N	081.2W	0729	23.7	24.6								1019.4
SPGF1	26.7N	079.0W	0739	22.6	24.6				8.8	E	22.1	26/08	1019.7
SRST2	29.7N	094.1W	0744	10.5					10.0	NE	29.5	15/05	1021.2
STDW4	47.2N	087.2W	0739	-7.7					20.2	W	42.0	22/20	1017.3
SVLS1	32.0N	080.7W	0743	11.4		0.9	2.4	01/11	13.3	NE	29.5	13/06	1022.1
TPLM2	38.9N	076.4W	0740	3.1	4.2				10.5	NW	27.4	31/19	1021.5
TTIW1	48.4N	124.7W	0744	5.2					15.1	E	42.0	25/19	1021.5
UJAP2	8.9N	165.8E	0744	27.3					16.6	E	26.1	19/13	1009.3
VENF1	27.1N	082.5W	0653	19.1	20.6				8.5	NE	25.0	20/05	1020.2
WPOM1	47.7N	122.4W	0742	5.6					9.2	S	29.8	13/04	1021.4
FEBRUARY 1991													
41001	34.9N	073.0W	0159	16.6	23.6	1.4	3.8	01/10	8.6	W	23.5	01/10	1028.7
41002	32.3N	075.2W	0672	17.8	22.4	2.2	8.6	15/23	14.6	SW	38.1	15/21	1018.3
41006	29.3N	077.4W	0529	19.5	22.0	2.3	8.3	16/06	15.0	E	35.0	15/23	1019.8
41008	30.7N	081.1W	0672	14.1	14.6	1.1	2.7	15/22	9.7	S	31.5	15/16	1020.1
41009	28.5N	080.2W	1343	19.6	22.5	1.5	4.5	02/12	13.3	NW	30.3	15/18	1019.3
41010	28.9N	078.5W	1342	20.0	23.0	2.0	5.5	15/23	15.2	NE	39.6	15/22	1019.2
42001	25.9N	089.7W	0672	20.2	22.1	1.3	3.2	01/00	13.5	N	25.5	18/08	1019.5
42002	25.9N	093.6W	0671	20.6	22.9	1.4	1.0	18/20	13.3	NE	25.6	18/04	1018.7
42003	25.9N	085.9W	0603	21.7	25.7	1.4	4.1	15/22	14.6	N	29.7	15/23	1019.8
42007	30.1N	088.8W	0435		15.1				12.7	N	30.3	15/14	1021.1
42019	27.9N	095.0W	0672	17.9	20.5	1.3	3.6	17/10	12.6	NE	26.0	20/08	1019.6
42020	27.0N	096.5W	0672	18.3	20.2	1.3	3.6	17/09	12.5	N	26.4	20/03	1019.6
44001	38.4N	073.7W	0670	7.1	9.3	1.4	3.8	16/10	13.5	SW	30.5	16/05	1017.8
44004	38.5N	070.7W	0667	9.9	16.4	2.0	6.4	01/02	16.0	W	31.9	15/17	1016.8
44005	42.7N	068.6W	0670	1.7	4.1	1.8	4.5	01/04	13.9	SW	34.0	01/03	1014.4
44007	43.5N	070.1W	0671	-0.3	4.1	0.8	4.5	14/19	12.5	SW	32.8	02/15	1015.1
44008	40.5N	069.4W	0672	3.9	5.4	1.8	4.8	01/06	16.0	W	36.9	01/03	1016.2
44009	38.5N	074.7W	0672	5.5		1.0	2.1	01/03					1017.8
44011	41.1N	066.6W	0659	3.4	4.4	2.3	5.9	15/03	14.2	SW	32.3	01/19	1014.4
44012	38.8N	074.6W	0670	5.0	6.2	0.9	2.2	14/23	14.7	S	34.4	16/09	1017.7
44013	42.4N	070.8W	0671	1.6	3.7	0.6	3.0	14/17	13.9	SW	32.3	22/20	1015.6
44014	36.6N	074.8W	0671	9.9	14.2	1.5	3.4	16/09	14.0	SW	28.2	14/15	1018.2
44015	37.5N	073.4W	0661	10.6	17.0	1.6	5.5	14/18	18.9	NW	32.6	16/04	1017.8
44023	37.5N	074.4W	0668	9.0	13.5	1.5	4.0	16/12	14.4	SW	30.3	20/15	1017.8
45002	45.3N	086.4W	0672	-2.7	2.3	0.9	3.5	16/21					1015.7
45004	47.5N	086.5W	0671		1.7	1.0	3.6	15/04					
46001	56.3N	148.3W	0672	1.0	3.3	3.2	7.8	09/02	15.5	W	29.5	08/19	997.8
46002	42.5N	130.4W	0672	11.2	10.7	3.3	7.3	11/15	13.5	S	32.4	04/08	1015.3
46003	51.9N	155.9W	0672	1.7	3.8	3.6	8.7	08/06	18.1	NW	34.0	23/19	994.4
46005	46.1N	131.0W	0669	8.9	8.8	3.3	6.3	04/18	13.2	S	34.8	04/10	1012.4
46010	46.2N	124.2W	0672	9.2	8.5	2.6	6.2	04/19	13.3	S	40.6	04/16	1017.4
46011	34.9N	120.9W	0671	12.6	13.2	2.2	4.1	04/06	10.3	NW	26.7	18/03	1018.8
46012	37.4N	122.7W	0672	11.2	12.0	2.2	4.4	12/18	10.7	NW	26.2	16/18	1019.2
46013	38.2N	123.3W	0671	10.8	11.5	2.3	4.5	03/22	10.1	NW	28.1	02/10	1019.3
46014	39.2N	124.0W	0672	10.6	11.4	2.4	4.4	02/14	10.0	NW	35.1	02/08	1019.3
46022	40.8N	124.5W	0290	10.0	10.9	2.0	3.4	20/08	6.3	N	18.7	26/19	1018.9
46023	34.3N	120.7W	0672	12.6	13.5	2.3	4.5	04/05	13.9	NW	30.2	27/21	1017.5
46025	33.8N	119.1W	0409	14.0	14.9	1.2	3.0	04/06	7.2	NW	23.7	27/23	1017.4
46026	37.8N	122.7W	0668	10.9	11.5	1.8	3.4	02/17	10.4	NW	34.0	02/12	1019.1
46027	41.8N	124.4W	0666	10.1	10.1	2.3	5.3	12/07	8.8	S	36.5	02/06	1018.9
46028	35.8N	121.9W	0670	11.8		2.4	4.7	12/13	11.8	NW	26.6	18/11	1019.2
46030	40.4N	124.5W	0234	10.1		1.9	3.2	21/02	9.8	N	22.0	26/19	1017.0
46035	57.0N	177.7W	0671	-4.3	1.3	2.5	6.0	26/17	18.6	N	39.1	26/16	1005.9

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
46041	47.4N	124.5W	0148	8.0	8.6	1.4	2.4	23/16	4.5	NE	12.6	23/05	1017.4
46042	36.8N	122.4W	0670	11.2	12.2	2.3	4.3	12/12	11.0	NW	25.8	02/13	1019.3
46045	33.8N	118.5W	0659	14.2	15.0	1.0	2.6	18/03	5.2	W	24.7	28/05	1017.5
51001	23.4N	162.3W	0672	22.4	23.5	3.2	6.3	28/08	12.5	NW	24.8	11/19	1014.3
51002	17.2N	157.8W	0671	24.7		2.6	4.0	16/09	12.2	E	24.5	16/13	1014.0
51003	19.2N	160.8W	0669	24.6	25.5	2.7	5.1	26/06	10.1	SE	23.0	14/04	1013.9
51004	17.5N	152.5W	0232	24.1	25.0	2.6	3.7	20/07	10.8	E	22.5	21/03	1012.5
ALSNG	40.5N	073.8W	0629	4.3	6.0	0.7	1.9	07/03	16.4	NW	35.2	01/00	1016.8
BURL1	28.9N	089.4W	0671	13.8					13.2	N	34.3	15/14	1019.4
BUSL1	27.9N	090.9W	0648	18.7	22.5				15.8	SE	38.0	18/08	1020.4
BUZM3	41.4N	071.0W	0671	2.6					17.0	SW	36.5	17/13	1016.6
CARO3	43.3N	124.4W	0671	10.6					10.0	S	31.4	01/20	1018.7
CHLV2	36.9N	075.7W	0670	7.7	7.9	0.9	2.3	08/20	15.5	N	32.1	14/15	1018.9
CLKN7	34.6N	076.5W	0671	10.3					10.3	N	30.4	16/03	1019.9
CSBF1	29.7N	085.4W	0530	14.5					7.9	E	35.8	15/08	1021.4
DBLN6	42.5N	079.4W	0666	-0.4					14.4	SW	37.4	15/23	1016.3
DESW1	47.7N	124.5W	0672	8.4					13.3	SE	46.2	01/16	1017.1
DISW3	47.1N	090.7W	0668	-5.0					12.3	SW	31.3	10/08	1017.3
DPIA1	30.3N	088.1W	0571	13.8	14.4				11.4	SE	31.2	15/16	1020.6
DSLN7	35.2N	075.3W	0667	12.1	16.2	1.5	3.8	14/16	16.7	N	40.1	14/10	1018.3
ENIP2	11.4N	162.4E	0671	26.7					16.4	NE	32.0	28/18	1010.2
FBIS1	32.7N	079.9W	0672	11.5					8.2	SW	27.0	23/19	1020.4
FFIA2	57.3N	133.6W	0670	3.5					15.0	SE	41.2	06/03	1008.4
FFSN7	33.5N	077.6W	0636	13.3	16.1				16.4	N	43.1	15/18	1019.0
GBCL1	27.8N	093.1W	0671	17.9	21.6				15.2	N	36.0	05/11	1020.0
GDIL1	29.3N	090.0W	0670	15.1	16.3				10.8	N	29.9	15/13	1020.3
GLAN6	43.9N	076.5W	0671	-2.1					13.3	SW	31.8	17/00	1015.5
IOSN3	43.0N	070.6W	0647	0.7					14.2	SW	37.1	22/20	1015.6
KOSP2	5.4N	163.0E	0670	27.9					9.1	NE	19.6	26/23	1008.7
LKWF1	26.6N	080.0W	0671	20.2	23.2				11.1	NW	26.3	03/18	1019.2
MDRM1	44.0N	068.1W	0671	-0.5					16.1	NW	42.0	01/17	1013.6
MISM1	43.8N	068.9W	0648	-0.3					15.7	SW	44.8	14/16	1014.0
MLIP2	6.1N	172.6E	0672	27.8					10.2	NE	22.5	13/00	1008.0
MLRF1	25.0N	080.4W	0671	21.7	23.8				13.5	E	32.2	16/03	1018.8
MPCL1	29.4N	088.6W	0670		18.4				13.7	NW	36.1	15/11	1019.9
NWPO3	44.6N	124.1W	0671	10.0					10.2	E	31.0	03/17	1017.9
PAGP2	18.1N	145.8E	0667	24.4					6.9	NE	16.9	27/15	
PILM4	48.2N	088.4W	0668	-6.2					13.3	NW	32.8	10/04	1016.2
PTAC1	39.0N	123.7W	0672	10.1					8.8	N	31.8	02/06	1019.6
PTAT2	27.8N	097.1W	0671	15.2	15.5				10.5	N	28.0	15/15	1019.7
PTGC1	34.6N	120.7W	0671	12.4					13.4	N	34.0	17/21	1018.0
ROAM4	47.9N	089.3W	0607	-6.0	0.5				13.3	NW	31.7	22/08	1018.0
SANF1	24.5N	081.9W	0669	22.1					12.8	E	29.3	16/03	1018.8
SAUF1	29.9N	081.3W	0671	14.9	15.5				9.0	N	27.5	01/06	1019.8
SBIO1	41.6N	082.8W	0588	0.3					12.7	SW	30.9	11/04	1019.7
SGNW3	43.8N	087.7W	0670	-2.3					11.7	W	26.5	15/02	1017.2
SISW1	48.3N	122.9W	0672	7.8					8.3	SE	40.0	04/18	1018.2
SMKF1	24.6N	081.2W	0662	22.1	23.5				13.7	NE	22.1	27/04	1019.2
SPGF1	26.7N	079.0W	0670	21.2	24.1				10.4	E	34.0	16/03	1018.9
SRST2	29.7N	094.1W	0602	13.6					10.3	N	25.7	16/22	1020.6
STDM4	47.2N	087.2W	0670	-4.3					17.0	NW	42.0	22/10	1015.8
SVLS1	32.0N	080.7W	0671	12.4		0.8	2.4	01/23	13.0	NE	39.7	15/13	1020.5
TPLM2	38.9N	076.4W	0669	4.8	4.3				11.0	S	28.9	16/04	1018.1
TTIW1	48.4N	124.7W	0672	7.9					16.4	NE	46.0	02/21	1017.3
UJAP2	8.9N	165.8E	0671	27.3					15.6	E	27.4	21/19	1009.7
VENF1	27.1N	082.5W	0672	17.7	19.7				9.7	E	34.1	15/18	1019.9
WPOL1	47.7N	122.4W	0672	8.3					8.4	S	26.3	12/07	1017.3
MARCH 1991													
32302	18.0S	085.1W	0388	21.2	21.8	1.7	2.6	27/01	10.3	SE	18.7	20/11	1015.1
33301	56.3S	027.6W	0067	-2.3									996.1
41002	32.3N	075.2W	0744	19.1	21.3	2.6	5.8	30/16	16.3	SW	28.9	04/00	1014.2
41008	30.7N	081.1W	0743	16.4	16.4	1.1	3.0	18/07	11.2	S	24.5	18/06	1015.0
41009	28.5N	080.2W	1487	20.4	21.6	1.3	4.3	18/05	13.1	S	28.0	10/04	1015.2
41010	28.9N	078.5W	1486	21.2	22.5	1.9	5.2	03/22	15.4	S	33.4	18/06	1015.5
42001	25.9N	089.7W	0744	21.5	22.0	1.5	3.8	10/13	13.8	SE	27.8	29/07	1013.7
42002	25.9N	093.6W	0742	22.1	23.2	1.7	3.5	04/00	15.3	SE	27.2	27/13	1012.2
42003	25.9N	085.9W	0731	23.3	25.7	1.6	5.1	03/09	16.3	S	33.6	03/04	1014.1
42007	30.1N	088.8W	0614	17.4	17.9				12.6	S	30.5	29/15	1015.1
42019	27.9N	095.0W	0744	19.7	20.3	1.6	3.9	16/12	12.8	SE	27.6	29/07	1012.3
42020	27.0N	096.5W	0743	20.5	20.7	1.6	2.9	16/18	13.3	S	28.4	29/06	1012.0
44001	38.4N	073.7W	0743	8.1	8.5	2.0	5.7	04/19	13.3	NW	28.4	11/12	1012.0
44004	38.5N	070.7W	0744	11.4	15.6	2.9	6.9	30/14	17.5	NW	41.8	19/02	1011.6
44005	42.7N	068.6W	0742	3.4	4.2	2.3	5.8	15/13	16.0	NW	30.1	15/00	1009.6
44007	43.5N	070.1W	0742	2.3	2.9	1.3	4.2	04/13	13.8	N	33.2	04/07	1010.8
44008	40.5N	069.4W	0744	5.3	5.5	2.5	6.1	19/12	17.2	NW	34.6	15/07	1010.8
44009	38.5N	074.7W	0741	7.4		1.4	3.6	15/00					1012.0
44011	41.1N	066.6W	0742	4.7	4.6	2.9	6.1	15/09	16.0	NW	32.4	15/09	1009.4
44012	38.8N	074.6W	0743	6.9	6.3	1.3	3.3	14/16	15.5	S	32.6	11/11	1011.8
44013	42.4N	070.8W	0743	3.8	3.9	1.1	4.4	15/06	15.5	NW	34.0	02/19	1011.0

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
44014	36.6N	074.8W	0744	10.8	13.7	1.9	3.8	30/09	14.1	NW	30.7	04/14	1012.7
44015	37.5N	073.4W	0732	11.9	15.7	2.2	5.9	04/17	15.8	N	32.4	04/17	1012.2
44023	37.5N	074.4W	0744	10.1	12.5	2.0	5.0	15/04	14.1	NW	29.1	18/17	1012.0
45002	45.3N	086.4W	0742	0.2	2.0	0.9	2.9	02/21					1011.2
45004	47.5N	086.5W	0651		1.0	0.9	3.8	28/08					
46001	56.3N	148.3W	0623	2.1	3.4	3.1	7.9	16/05	16.2	W	37.7	16/05	1011.2
46002	42.5N	130.4W	0743	9.0	10.7	3.4	6.1	16/18	14.3	N	30.7	20/07	1014.3
46003	51.9N	155.9W	0743	3.3	3.6	3.7	7.8	28/13	19.0	W	41.0	28/11	1015.6
46005	46.1N	131.0W	0742	7.1	8.9	3.2	6.2	17/01	14.6	NW	28.2	26/02	1012.3
46010	46.2N	124.2W	0744	7.5	8.3	2.4	4.9	02/15	11.2	NW	34.4	03/19	1011.1
46011	34.9N	120.9W	0743	11.7	12.5	2.9	5.0	02/15	12.8	NW	31.9	17/18	1016.0
46012	37.4N	122.7W	0743	10.6	11.6	2.8	5.8	21/04	14.6	NW	34.6	17/10	1014.2
46013	38.2N	123.3W	0742	10.3	11.2	2.9	5.7	21/02	15.1	N	32.9	15/07	1013.7
46014	39.2N	124.0W	0741	9.7	10.9	3.1	5.7	17/22	15.0	NW	33.9	03/10	1013.0
46022	40.8N	124.5W	0742	9.2	10.3	3.1	5.6	02/20	15.1	S	39.6	03/11	1012.7
46023	34.3N	120.7W	0743	11.7	12.6	2.9	5.8	02/19	14.1	NW	33.1	19/06	1015.1
46025	33.8N	119.1W	0221	13.7	14.5	2.3	4.7	01/13	8.5	W	24.5	01/12	1016.7
46026	37.8N	122.7W	0743	10.2	11.2	2.2	4.6	02/14	16.3	NW	39.4	03/13	1014.0
46027	41.8N	124.4W	0728	8.6	9.9	2.7	5.7	03/12	13.5	N	38.9	03/11	1012.3
46028	35.8N	121.9W	0464	11.6	12.3	2.8	5.2	21/07	13.4	NW	27.1	07/03	1015.9
46030	40.4N	124.5W	0641	9.3		2.7	5.4	21/08	15.1	N	40.4	03/10	1012.5
46035	57.0N	177.7W	0742	-0.4	1.2	3.7	8.7	13/01	19.1	S	36.7	11/13	998.8
46040	44.8N	124.3W	0133	8.7	9.1	2.1	3.6	30/23	8.8	N	16.9	27/11	1020.0
46041	47.4N	124.5W	0744	7.0	8.6	2.3	4.3	15/09	9.7	SE	27.6	02/12	1010.5
46042	36.8N	122.4W	0743	10.8	11.7	3.0	6.0	21/06	13.8	NW	34.4	17/11	1015.1
46045	33.8N	118.5W	0731	12.6	13.9	1.4	4.7	19/14	8.9	W	30.5	19/13	1015.5
51001	23.4N	162.3W	0742	21.7	22.9	3.3	5.5	03/13	17.8	E	26.9	16/16	1019.9
51002	17.2N	157.8W	0743	23.9		3.2	5.5	14/11	18.7	NE	32.2	19/22	1015.9
51003	19.2N	160.8W	0467	23.3	24.9	3.4	5.0	04/02	17.6	E	30.6	13/20	1016.4
51004	17.5N	152.5W	0744	23.5	24.5	3.1	4.5	13/21	17.5	NE	27.5	13/18	1016.0
ALSN6	40.5N	073.8W	0646	5.5	6.1	1.1	2.9	14/22	18.1	N	37.4	28/20	1012.8
BURL1	28.9N	089.4W	0744	16.9					14.6	S	35.9	01/20	1013.3
BUSL1	27.9N	090.9W	0727	20.9	23.1								1013.7
BUZM3	41.4N	071.0W	0743	4.5					17.2	NW	37.6	24/01	1011.7
CARO3	43.3N	124.4W	0741	7.8					10.3	N	41.5	03/20	1012.6
CHLV2	36.9N	075.7W	0743	10.0	8.6	1.1	2.8	16/14	16.3	N	35.4	02/10	1013.1
CLKN7	34.6N	076.5W	0742	13.3					11.2	SW	29.1	30/07	1014.5
CSBF1	29.7N	085.4W	0711	17.0					8.3	SE	30.7	03/06	1014.9
DBLN6	42.5N	079.4W	0740	2.7					12.9	SW	51.1	28/11	1011.9
DESW1	47.7N	124.5W	0744	8.6					10.8	SE	34.3	02/12	1010.9
DISW3	47.1N	090.7W	0743	-2.6					12.8	NE	35.1	23/06	1013.0
DPIA1	30.3N	088.1W	0744	16.7	17.2				12.2	SE	29.4	04/01	1013.9
DSLNI	35.2N	075.3W	0725	14.7	18.2	2.0	5.5	04/03	20.8	N	44.6	30/03	1013.4
ENIP2	11.4N	162.4E	0739	26.9					18.4	E	26.9	02/15	1009.7
FBIS1	32.7N	079.9W	0741	14.7					10.3	SW	36.2	03/18	1014.8
FFIA2	57.3N	133.6W	0741	2.5					13.6	N	39.5	02/21	1010.4
FFSN7	33.5N	077.6W	0743	15.9	16.4				18.6	SW	49.7	30/08	1014.4
GBCL1	27.8N	093.1W	0726	19.7	21.1	1.2	2.9	22/16	17.0	S	34.5	29/09	1012.7
GDIL1	29.3N	090.0W	0743	17.9	19.2				11.9	S	28.6	30/05	1014.0
GLLN6	43.9N	076.5W	0730	0.9					13.6	W	41.9	28/13	1011.9
IOSN3	43.0N	070.6W	0712	3.2					16.4	NW	41.7	04/10	1011.3
KOSP2	5.4N	163.0E	0743	27.3					7.6	NE	25.7	20/08	1008.2
LKMF1	26.6N	080.0W	0743	22.1	23.2				13.0	S	32.6	03/18	1015.6
MDRM1	44.0N	068.1W	0741	2.1					19.4	NW	40.0	04/11	1009.2
MISM1	43.8N	068.9W	0685	2.3					19.3	NW	45.5	04/12	1009.4
MLIP2	6.1N	172.6E	0741	27.1					11.1	NE	27.5	31/14	1008.5
MLRF1	25.0N	080.4W	0744	23.3	24.0				13.8	SE	39.3	04/01	1015.6
MPCL1	29.4N	088.6W	0718	18.2	19.3	1.1	3.2	29/23	15.2	SE	36.6	17/13	1013.7
NMPO3	44.6N	124.1W	0743	7.3					8.9	E	40.0	11/23	1012.2
PAGP2	18.1N	145.8E	0740	25.7					8.5	NE	16.7	09/03	
PIIM4	48.2N	088.4W	0692	-3.2					12.4	E	34.2	06/02	1014.2
PTAC1	39.0N	123.7W	0742	9.0					11.7	N	29.6	02/20	1013.7
PTAT2	27.8N	097.1W	0742	18.8	18.7				12.8	SE	29.5	30/06	1011.8
PTGC1	34.6N	120.7W	0740	11.4					13.9	NW	40.5	19/07	1015.6
ROAM4	47.9N	089.3W	0669	-3.0	0.2				11.8	NE	35.2	06/13	1015.2
SANF1	24.5N	081.9W	0743	23.3					12.9	SE	31.6	10/08	1015.3
SAUF1	29.9N	081.3W	0743	17.3	17.5				10.4	SW	27.5	09/18	1015.0
SBJO1	41.6N	082.8W	0741	3.7					14.2	W	43.8	28/06	1011.8
SGNM3	43.8N	087.7W	0743	1.1					13.7	N	36.0	02/20	1011.0
SISM1	48.3N	122.9W	0742	6.3					8.2	SE	33.0	09/16	1011.6
SNKF1	24.6N	081.2W	0737	23.5	23.8				14.5	SE	34.6	10/08	1015.8
SPGF1	26.7N	079.0W	0743	22.7	24.7				8.6	SW	29.3	10/13	1015.6
SRST2	29.7N	094.1W	0720	16.6					11.0	SE	31.2	01/11	1013.6
STDM4	47.2N	087.2W	0730	-1.7					16.2	E	42.0	02/12	1013.1
SVLS1	32.0N	080.7W	0743	15.0		0.9	2.4	29/23	15.1	S	34.7	03/21	1014.6
TFIM2	38.9N	076.4W	0744	7.7	6.8				11.9	NW	31.9	24/22	1012.5
TTIW1	48.4N	124.7W	0743	6.0					11.7	NE	39.0	01/12	1011.2
UTAF2	8.9N	165.8E	0744	27.1					16.9	E	30.0	01/00	1009.5
VENF1	27.1N	082.5W	0744	19.5	20.9				10.3	S	26.7	04/18	1015.7
WFOW1	47.7N	122.4W	0744	6.7					8.8	S	27.8	02/15	1010.5

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